AD NUMBER
AD483962
LIMITATION CHANGES
TO: **Approved for public release; distribution is unlimited.**
FROM: **Distribution authorized to U.S. Gov't. agencies and their contractors; Administrative/Operational Use; 15 MAR 1966. Other requests shall be referred to Air Force Systems Command, Andrews AFB, Washington, DC.**
AUTHORITY
AFSC ltr 20 Dec 1973

Best Available Copy

AD No. 483962
DDC FILE COPY

BETARS | JOINT ARMY — AIR FORCE TACTICAL RECONNAISSANCE SURVEILLANCE STUDY

APPENDIX B

TOPOGRAPHY AND CLIMATE

BSR 1247

MARCH 15, 1966

THE Bendix CORPORATION
BENDIX SYSTEMS DIVISION · ANN ARBOR, MICHIGAN

APPENDIX B.

TOPOGRAPHY AND CLIMATE.

BSR-1247-App-E

MARCH 15, 1966,

PREPARED FOR
AIR FORCE SYSTEMS COMMAND
CONTRACT AF 18(600)2804

THE Bendix CORPORATION
BENDIX SYSTEMS DIVISION

CONTENTS

CONTENTS (CONT.)

CONTENTS (CONT.)

CONTENTS (CONT.)

ILLUSTRATIONS

ILLUSTRATIONS (CONT.)

ILLUSTRATIONS (CONT.)

ILLUSTRATIONS (CONT.)

TABLES

TABLES (CONT.)

TABLES (CONT.)

SECTION I

INTRODUCTION

This appendix presents summaries of information on the climate and topography of geographical areas studied in BeTARS. The most detailed analysis is on one Southeast Asia area but with corresponding support data on others.

The purpose of this summary is to provide a document that may be used as a reference for analysis of operations in these geographical areas. For this purpose, each set of information has been made as complete as possible.

The information is in part derived from data provided by the Air Weather Service (climate) and from computer analysis of contour maps for selected regions (terrain masking). Information from the "Proceedings of the Third Symposium on Remote Sensing of Environment," the "Counter-insurgency Study, Volume II - Missions and Geography," and the BeTARS Scenarios (Number 1 through 5), has also been incorporated where necessary to present a comprehensive body of information on each area.

Each sensor is affected differently by various geophysical and meteorological parameters. Geophysical parameters such as latitude, time of year, and time of day will have a pronounced effect upon photographic, optical, and television (TV) sensors, a secondary effect upon infrared (IR) sensors, and no effect upon radar sensors. Similarly, meteorological factors such as cloud type, cloud cover, fog, haze, smoke precipitation, temperature inversion, and surface wind will produce varying effects upon each sensor. To incorporate the geophysical and meteorological parameters into an analytical model, it is necessary to reduce these parameters to a limited number of categories.

1.1 GEOPHYSICAL

The main effect produced by the geophysical parameters is to vary the illumination on the surface of the earth. The total irradiance on a horizontal surface in foot-candles is a function of solar altitude (sun elevation

in degrees). The solar altitude is dependent upon the latitude, time of year, and time of day. Data on solar altitude versus latitude, time of year, and time of day are readily available and such data may be stored in the computer. Irradiance resulting from direct sunlight, skylight, and the total irradiance on horizontal and vertical planes on the surface of the earth is presented in Table 1-1. The performance of photographic and optical sensors is directly affected by the irradiance at the surface of the earth. The natural diurnal illumination (irradiance) variations at the earth's surface are shown in Table 1-2 and Figure 1-1.

In most cases, latitude and time of year will not greatly affect the performance of IR sensors. However, the thermal time history of targets and backgrounds will have a pronounced effect upon the performance of IR sensors. The temperature differences of various types of terrain measured over a 24-hr period are presented in Figure 1-2 which illustrates that the contrast between target and background can differ greatly, depending upon the time of day.

Geophysical factors, except for surface wind in the case of MTI radar, have little effect upon radar sensors. The surface wind speed will usually have a minimum value at a particular time of day, thus improving the performance of the MTI radar during these periods of minimum wind velocity.

1.2 METEOROLOGY

Optimum performance of all sensors is obtained under clear weather conditions. The presence of clouds, haze, fog, precipitation etc, will degrade each sensor by a specific amount. Photographic and TV sensors are most severely affected by weather parameters; except for rain or wind, radar is unaffected by weather parameters.

---

*Illumination at ground level is the sum of light from two directions-sunlight and skylight. Sunlight is transmitted directly through the atmosphere while skylight comes from the light scattered from the atmosphere and clouds. Daylight is the sum of the two components.

TABLE 1-1

IRRADIANCE RESULTING FROM DIRECT SUNLIGHT AND SKYLIGHT; AND TOTAL IRRADIANCE ON HORIZONTAL AND VERTICAL PLANES AT SURFACE OF EARTH

Solar Altitude	Direct Sunlight		Sky Light		Total	
	Horizontal Surface	Vertical Surface	Horizontal Surface	Vertical Surface	Horizontal Surface	Vertical Surface
(degrees)	(foot-candles)		(foot-candles)		(foot-candles)	
3	19.6	374	256	258	277	961
5	100	1150	325	746	425	1900
7	252	2050	395	848	647	2900
10	590	3350	491	953	1080	4300
15	1310	4910	629	1070	1940	5880
20	2130	5860	750	1140	2880	7000
25	2980	6390	856	1180	3840	7570
30	3820	6620	945	1210	4760	7830
35	4650	6640	1020	1220	5670	7860
40	5440	6490	1090	1220	6530	7710
45	6170	6170	1160	1220	7330	7390
50	6850	5750	1210	1200	8060	6950
55	7450	5220	1270	1180	8720	6400
60	8000	4620	1310	1150	9310	5770
65	8470	3950	1350	1090	9820	5040
70	8860	3230	1390	1020	10250	4250
75	9160	2450	1420	930	10580	3380
80	9380	1650	1440	834	10820	2480
85	9510	833	1460	728	10970	1560
90	9570	00	1480	615	11050	615

TABLE 1-2

VARIATION OF NATURAL ILLUMINATION

Natural Illumination	Irradiance (foot-candles)
Sunlight-noon	10^4
Sunlight - 30^o	5×10^3
Sunlight-twilight	3×10^2
Moonlight-full moon	10^{-2}
Moonlight-half moon	10^{-3}
Night-no moon	10^{-4}

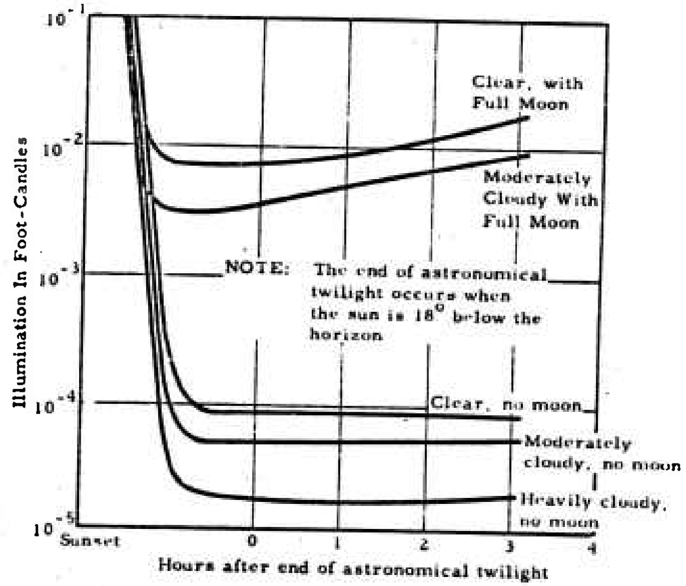


Figure 1-1 Natural Illumination at Night at Ground Level

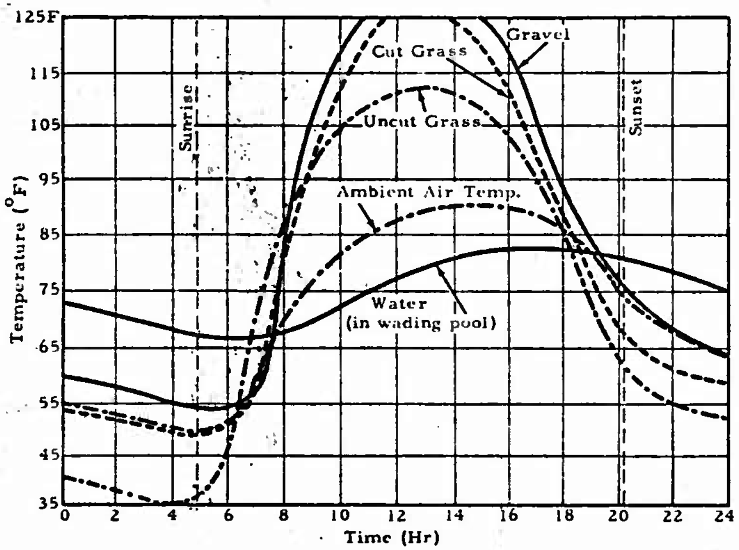


Figure 1-2 Temperature Differences of Various Types of Terrain Measured Over a 24-Hour Day in Michigan on a Day in June

1.2.1 Cloud

The amount of cloud cover is defined in terms of tenths. The weather observations will specify clear (0/10), scattered (1/10-4/10), broken (5/10-9/10), and overcast (10/10) cloud conditions. The attenuation of irradiance, after it has been determined for the overcast cloud condition, can be reduced corresponding to the amount of cloud cover for scattered and broken cloud conditions.

The cloud type and altitude for simplicity may be divided into three distinct categories:

1. Cirrus and cirrustratus-high altitude (30,000 to 40,000 ft)

2. Altocumulus-middle altitude (10,000 to 15,000 ft)

3. Cumulus, stratus, and stratocumulus-low altitude (3,000 ft).

Cumulonimbus (thunder) clouds have not been considered, since it is unlikely that reconnaissance will occur in the presence of cumulonimbus clouds. An illumination attenuation factor can be determined experimentally for each type of cloud. This attenuation factor will be similar to the camera exposures provided by film manufacturers. Approximate attenuation values produced by various clouds are presented in Table 1-3

TABLE 1-3

ILLUMINATION TRANSMISSION ATTENUATION
DUE TO CLOUDS AND PRECIPITATION

Cloud Type	Resulting Light (%)
High clouds (cirrus)	50
Medium clouds (altocumulus)	20
Low clouds (stratocumulus, cumulus, and stratus)	10

Precipitation Type	Rate mm/hr	Rate Inches/hr	Resulting Light
Light rain (medium clouds)	3	0.12	10
Drizzle (stratus clouds)	3	0.12	5
Moderate rain (cumulus)	7	0.28	5
Heavy rain (cumulus)	100	3.95	1

1.2.2 Visibility

The visibility reported by weather stations is the horizontal visibility, which is usually less than the vertical visibility, or visibility along slant line of sights that is more applicable to reconnaissance. It is possible to estimate the vertical visibility if the horizontal visibility and the altitude of the haze layer top is known.

Atmosphere, a serious limitation for high-altitude reconnaissance, reduces the contrast of ground objects, giving the earth surfaces the appearance of having a low brightness modulation. This effect is the result of two phenomena: first, the scattering of light from the sun, and second, scattering and absorption of energy reflected from objects in the atmosphere. This reduction of contrast in the optical image is directly translatable into a reduction in modulation and thus becomes a signal-to-noise problem.

In the atmosphere, both absorption and scattering operate simultaneously to attenuate the transmission. In many cases, either absorption or scattering may be negligible with respect to the other, but both processes usually operate concurrently. Because it is often difficult to measure them separately, it is a common practice to refer to the "extinction coefficient" of the atmosphere, which is the total of the scattering and absorption coefficient.

In any optical medium, the brightness of an object seen against a black background is attenuated with distance. Bouger's law defines this relationship as:

$$B_R = B_o e^{-\sigma R}$$

where

B_R = apparent brightness at range R

B_o = intrinsic brightness of an object

σ = extinction coefficient

$= b + k$

b = scattering coefficient

k = absorption coefficient.

The attenuation of visual and IR radiation in the atmosphere results mainly from scattering by suspended particles and absorption by atmospheric gases, the two most important absorbents being water and carbon dioxide, with water vapor the more important of the two. The attenuation caused by scattering varies much more simply with wavelength than does the absorption by a given concentration of absorbent. Absorption occurs mainly in certain wavelength bands separated by windows of negligible absorption, while natural haze scattering is a fairly continuous function of wavelength.

Atmospheric scattering is commonly referred to as haze. The various degrees of haze range from the very small scattering on clear days, which is very dependent on wavelength, to fog. The foggier the atmosphere, the greater the scattering, and since fog appears white, the scattering is independent of wavelength.

If the atmosphere contains particles whose linear dimensions are considerably smaller than the wavelength, and if there is negligible absorption, the scattering is proportional to the inverse fourth power of the wavelength. This scattering is known as Rayleigh scattering. Rayleigh scattering applies to scattering of sunlight by the molecules of the permanent gases in the atmosphere, such as are found in the atmosphere at high altitudes.

Natural haze occurring at low altitudes is less selective than pure Rayleigh scattering. For particles such as haze and fog whose linear dimensions are in the range of 0.1 to 10 wavelengths, a different theory known as the Mie theory applies. The theory of Mie scattering considers the electromagnetic waves of light inside and outside a small sphere and, after putting in appropriate boundary conditions, derives differential equations which may be solved to give the electric and magnetic vectors at any point. The illuminance at this point is proportional to the average vector product. As with Rayleigh scattering, absorption is considered to be negligible.

As the particle size becomes larger, the atmosphere is said to go from haze to fog, defined as an atmosphere containing a large number of water droplets larger than several microns. The Mie theory states that large particles, being much larger than the wavelength of the radiation, will scatter completely independently of wavelength. Measurements show that there is a sudden change to nonselective scattering near the point where haze changes to fog, the point where hygroscopic nuclei may be supposed to start increasing in radius in an unstable manner.

It has been determined experimentally that up to 10,000 ft the scattering tends to be independent of wavelength, while at 50,000 ft the scattering is close to that for Rayleigh scattering. Consequently, for low-altitude reconnaissance, an integrated scattering coefficient must be determined. Approximate values of the visual scattering coefficient, the meteorological range, IR attenuation, and microwave attenuation are presented in Table 1-4. A useful quantity related to the scattering coefficient is the "meteorological range" which is defined as the distance at which the contrast is reduced to 2%, a value where detection is still definite if the object appears large enough.

If the horizontal visibility exceeds 7 miles (mi), the meteorological reporting station as a rule does not note the type of obstruction reducing the visibility. Usually, if the horizontal visibility exceeds 7 mi, the vertical visibility will be adequate for aerial reconnaissance. When the horizontal visibility is 7 mi or less, the reporting station is required to note the obstructing medium. Consequently, a scattering coefficient may be computed for this obstructing medium.

1.2.3 Surface Temperature

The ability of IR sensors to detect targets such as water is dependent upon the temperature of the background (i.e., surface temperature of the earth). If the surface temperature of the earth is low, an IR sensor will have an increased probability of detecting warm targets. The surface temperature reported by meteorological reporting stations is actually the air temperature 4 ft above the earth's surface. Under certain conditions there can be a considerable difference between this temperature and the temperature of the earth's surface. Consequently, the surface temperature reported by the weather station must be modified to determine the detection capability of the IR sensor.

TABLE 1-4

VISUAL SCATTERING COEFFICIENT, VISUAL METEOROLOGICAL RANGE, INFRARED ABSORPTION, AND MICROWAVE TWO-WAY ATTENUATION FOR VARIOUS TYPES OF WEATHER

Weather Condition	Visual Scattering Coefficient (km^{-1})	Visual Meteorological Range (km)	Infrared Absorption (%)	Microwave 2-Way Attenuation (db per km)		
				S-Band	X-Band	Ka-Band
Exceptionally clear	0.05	80		0.01	0.02	0.18
Very clear	0.2	20		0.01	0.02	0.18
Clear	0.4	10	5	0.01	0.02	0.18
Light haze	1	4		0.01	0.02	0.18
Haze	2	2	10	0.01	0.02	0.18
Thin fog	4	1		0.01	0.02	0.02
Light fog	8	0.5	70	0.01	0.02	0.22
Moderate fog	20	0.2	95	0.01	0.06	0.50
Light rain (3 mm/hr)			100	0.01	0.30	2.00
Moderate rain (7 mm/hr)			100	0.01	0.40	4.00

1.2.4 Surface Wind

The meteorological reporting station reports the surface wind in units of miles per hour (mph). The surface wind has a pronounced effect upon MTI radar, causing the radar to become less sensitive as the surface wind increases in magnitude. The surface wind has a secondary effect upon IR sensors causing the contrast to become less as the surface wind increases.

1.2.5 Precipitation

As seen in Table 1-4, with the exception of the S band microwave radar, all reconnaissance sensors are adversely affected by rain. Snow causes adverse scattering for all sensors but radar. Of all reconnaissance sensors, radar is least affected by precipitation.

1.2.6 Air Mass

Direct correlations have been sought between the atmospheric extinction coefficient (atmospheric contrast reduction parameter) and various specific meteolorogical parameters such as ground visibility, haze heights, the number of temperature inversions in the atmosphere, total precipitable moisture content, the vertical extent of humid layers (relative humidity in excess of 60%), the polarization ratio of skylight, and the air mass type. No correlation has been found with the visibility, the total precipitable moisture content, or polarization data. The vertical extent of humid layers of atmosphere and the general air mass classification do appear to exhibit some correlation with the contrast data. The criteria (number of temperature inversions, presence of haze layers, and visibility) which have been used to classify atmospheric conditions as to their suitability for aerial photography have lead to ambiguity.

As a first approximation, a simple air mass classification criterion may be developed to determine the performance of each sensor. However, it would be necessary to modify this criterion for local weather factors such as smoke, fog, and precipitation. The presence of a continental polar air mass results in the "most favorable" to "intermediate" condition, while a maritime tropical air mass results in "least favorable" conditions. A more detailed analysis of the air mass classification which takes into account the general and local advection within the air mass and the season of occurrence may be postulated as follows:

Visibility	Air Mass
Very clear	cA-any continental artic air (winter)
	cPk-continental polar air with cold air advection (winter)
	cP-any continental polar air (summer)
Moderately hazy	cPw-continental polar air with warm air advection (winter)
	mTk-maritime propical air with cold air advection (summer)
Very hazy	mTw-maritime tropical air with warm air advection

SECTION 2

TOPOGRAPHY, VEGETATION, AND CLIMATE OF INDOCHINA

2.1 TOPOGRAPHY

Indochina lies between China and India and consists of four provinces: South Vietnam, North Vietnam, Laos, and Cambodia (Figure 2-1). Mountains and hills varying from 15,000 ft in northern Burma to 10,000 ft in Laos dominate the terrain of Southeast Asia, (Figure 2-2). Valley and intermountain basin floors are from 1500 to 5000 ft above sea level. Steep slopes are common throughout, usually exceeding 30%; peaks typically stand 1500 to 5000 ft above valley floors.

Plains border the large streams of the area, being most extensive in the vicinity of Bangkok and from Saigon south and west in the vast Mekong Delta. Less extensive plains join the highlands and border the coast of most of Southeast Asia. Drainage features are numerous, being especially dense in the poorly drained delta areas near Bangkok and Saigon. Slopes on the plains are commonly less than 2% and local relief is less than 100 ft.

Plateaus occupy only a small part of the area. The most extensive plateau, Korat, is in northern Thailand; smaller ones are in Laos, South Vietnam, and Cambodia. These elevated rolling-to-flat plains are dissected by steep-banked streams and interrupted by scattered areas of hills and low mountains.

Surface material consists of coarse soil and bedrock in the mountains, and fine to coarse soils on the lowland plains. Streams generally flow from north to south and are steep-banked, except in the plains where the banks are nearly flat. Bottom materials range from gravel in and near the mountains to muddy silt in the plains.

Figure 2-1 Weather Reporting Stations in Indochina

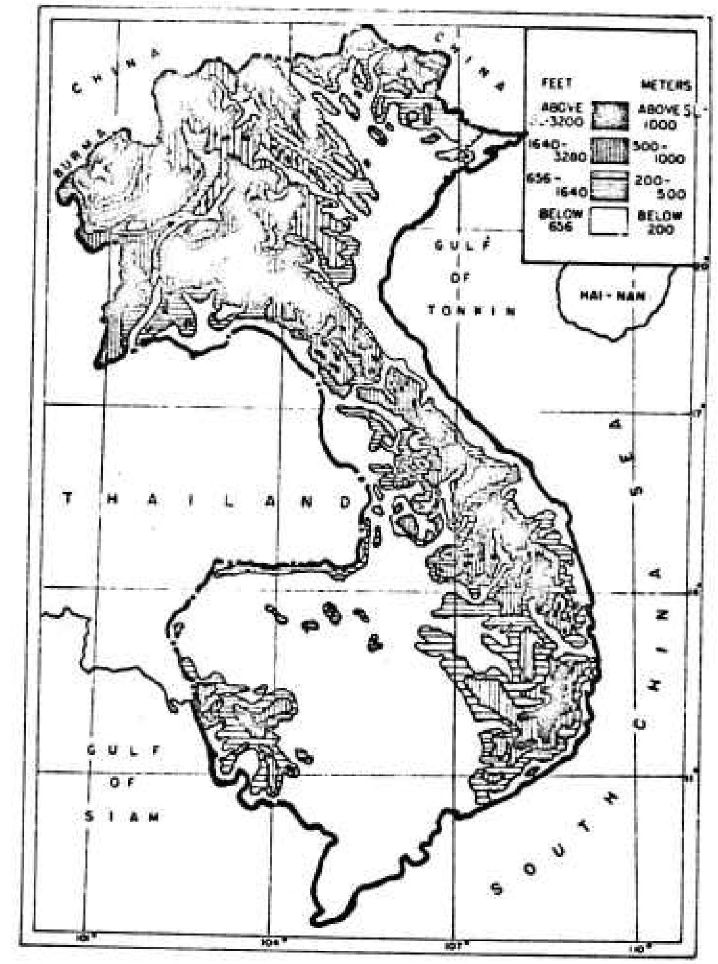


Figure 2-2 Elevation of Indochina

2.2 VEGETATION

Evergreen and deciduous trees cover about 65% of Southeast Asia; the remaining 35% is mainly under cultivation, chiefly in wetland rice. Dense-to-open forests occur mainly in the mountains, interior plains, and hills. The undergrowth of bamboo, shrubs, and brush is typically dense. In the deciduous forest, the undergrowth becomes matted during the dry period and is commonly fireswept; the trees are leafless from December through March. Trees of 20 to 200 ft in height are generally 6 to 16 ft apart in the dense forests and 12 to 40 ft apart in open forests.

2.2.1 Tropical Rain Forest

The tropical rain forest is found in areas having an annual rainfall of approximately 80 in. or more which is distriubted fairly evenly throughout the year. The amount of moisture required to support a tropical rain forest will vary with the soil conditions. The tropical rain forest is found on the plains and slopes to an approximate altitude of 2300 ft. This forest contains a great variety of plant species, a high proportion of which are tree species. The rain forest in its natural state exhibits three layers of vegetation: (1) trees from 75 to 90 ft tall; (2) below them grow trees whose natural height is about 50 to 65 ft; (3) the third layer is composed of young, immature trees. Bushes and other smaller plants are not found because of the lack of light on the forest floor. If the tropical rain forest is cleared and then abandoned, a "secondary rain forest" type results. The trees are smaller and more closely spaced; the slower growing hardwoods are scarcer. Climbing vegetation is more common in the secondary rain forests which are widespread throughout Indochina.

2.2.2 Tropical Monsoon Forest

The tropical monsoon forest develops when the annual rainfall is 60 to 80 in. This type of vegetation is distinguished by the shedding of leaves during the dry seasons. A typical monsoon forest species is a rank type of grass known as tranh which can be used for grazing when it is young. The monsoon forest is so frequently burned that it is nearly all a secondary forest type. If the bamboo forest is cleared and abandoned, herbaceous plants first establish themselves followed by wild bananas and bamboo.

2.2.3 Pine Forests

Pine forests are found at altitudes above 2300 ft or at lower levels near the coast. Some oaks and magnolias may be associated with the pine trees. The pine forests are subject to fire which destroy the young trees and undergrowth.

2.2.4 Mangrove Forests

Mangrove forests are found along the muddy stretches of the coast. Mangrove is a general term for all types of trees and bushes that can exist in the mud of seashores and estuaries. Mangrove forests usually grow in a narrow, impenetrable belt above the high-tide level.

2.2.5 Savanna

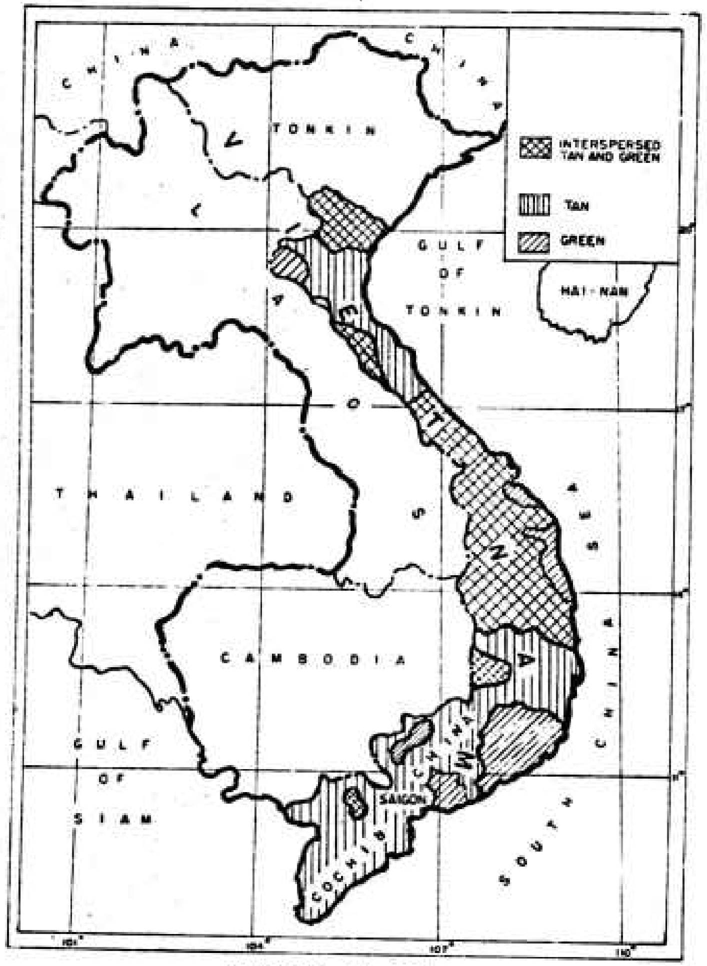
Savanna has replaced the burned monsoon forest in many localities instead of a secondary forest, usually where the soil is poor. Some scattered deciduous trees or evergreen shrubs may occur in the savanna regions. During the dry season, the vegetation appears parched and brown.

2.2.6 Other Vegetation Types

The most widespread cultivated vegetation is wetland rice. It is grown in water 4 to 12 in. deep and reaches a height of about 1 m when mature. Rice is commonly planted from June to September and cultivated from December through March. Second crops are planted where water for irrigation is available, chiefly in the lowlands around Bangkok and Saigon. If no second crop is planted, the fields are left either in stubble or planted in corn, beans, or similar crops.

Around villages in rice areas (along the largest streams) are small plantations, typically of coconut palms, rubber trees, and sugar cane. Mangrove swamps line much of the southern coastlines; fresh water swamp forests occur locally, particularly in the Mekong River Delta.

The seasonal color regions of Indochina are shown in Figure 2-3.



SEPTEMBER - ALL GREEN

Figure 2-3 Color Regions of Indochina During January

2.3 CLIMATE

Indochina has a tropical monsoon climate with high temperature and high humidity. The weather is characterized by two seasons: Northeast Monsoon (November to April), and Southwest Monsoon (June to October). The remaining months are transitional.

Indochina's climate is controlled chiefly by latitude, topography, and proximity to the large Asian landmass. Indochina extends from 9° to 23°N. latitude, thus lying wholly within the tropical zone. Temperatures are uniformly high throughout the year with the greatest annual ranges occurring in the northern portion of the country. The highest temperatures are recorded during the period from April through September—the maximum often preceding and just following the summer monsoonal rains.

Indochina has a coastal Am and an interior Aw climate. Both climates are divided by a mountainous Cw climate ridge. The ridge is often defined as the Indochina subtropical region The climate symbols (Koeppen's Classification) are defined as follows:

Am = zone of tropical rainy climate with monsoon rains, giving evergreen forests

Aw = hot, damp primary forest climate

Cw = zone of warm temperature, rainy climate, with dry winters.

The climatic regions of Indochina are shown in Figure 2-4.

Indochina's low-latitude location is significant in terms of precipitation which is concentrated in the summer-half of the year when every section of the country experiences strong vertical solar insolation at some time or other as the sun's zenith position passes toward and away from the Tropic of Cancer. The strong insolation is responsible in tropical areas for convectional afternoon precipitation. The amount of precipitation is dependent upon the available source of moisture.

Topography is significant in lowering temperatures, producing orographic precipitation, and acting as a climatic barrier. Those areas in Indochina lying at high elevations above sea level experience lower

Figure 2-4 Climatic Regions of Indochina

annual temperatures. Mountain ranges lying in the path of moisture-bearing winds force these winds to rise over them; in this process, the winds are cooled and heavy precipitation results on the windward slopes. By contrast, the leeward slopes may be quite dry and warm up as they descend to the rear of the highlands. In Indochina, orographic precipitation is most pronounced on the southerly slopes of mountains during the summer months. Leeward areas tend to have a drier climate because of the barrier situation.

Pressure and wind conditions in Indochina are strongly influenced by the Asian landmass. During the summer months, pressure over the country is relatively low which, coupled with the northward migration of the equatorial pressure system, results in the country being subjected to an inflow of warm, moist southeast, south, and southwest winds (dependent upon location). These are the winds responsible for the heavy summer rainfall known as the Summer Monsoon. During the winter months, high pressure prevails over the land areas. The equatorial pressure system is then to the south of the country and the prevailing winds are from the north, northeast, or parallel to the coast in places. This is known as the Winter or Northeast Monsoon. Since the winds are relatively dry and their flow towards the equator results in their being warmed rather than cooled, precipitation at this time of the year is much less than during the Summer Monsoon. Winter is Indochina's dry season, although some precipitation does occur on windward slopes and in certain areas as a result of special weather conditions.

Air operations are affected by excessive cloudiness, especially during the summer. The best flying conditions are found over the interior plains during winter, while the likelihood of maximum visibility exists during the transitional period between winter and summer. The best visibility for flying during the daytime usually occurs between the hours of 1000 and 1200, after the early morning fog has burned off, and before the afternoon cumulus buildup. The number of days suitable for photographic missions varies from season to season and also between localities. It should be noted that conditions in the coastal areas may be quite different from those in the interior. Visibility is usually the poorest during the summer monsoonal rains and in areas under the influence of crachins and typhoons. The northern part of Indochina averages more days of poor visibility than the southern part.

2.3.1 Crachin (Fog)

The crachins, which are prolonged periods of drizzle or light rain accompanied by low, heavy stratus clouds and fog, occur in the Gulf of Tonkin, in the Tonkin Plain, and along the northern coast of Vietnam. The tops of the stratus clouds average 6000 ft.

The crachins start around the latter part of December and extend through March and sometimes into April. The period of a crachin usually lasts from 2 to 5 days, although one crachin may closely follow another with no clear interruption between them. Crachins may seriously delay or prevent sea and land operations and render combat operations of aircraft virtually impossible.

The humidities over the coastline east of the Annam cordilleras are low. Therefore, the visibility is generally good for this part of South Vietnam, with the percentage of monthly observations reporting visibilities of less than 2 nautical miles (n. mi.) equal to or less than 5%. During the months of November through January, the percentage of observations reporting visibilities less than 5 n. mi. in the southern part of the coastal area of Vietnam is 8%. In the coastal area of Tonkin, fogs are quite frequent between December and February. These fogs are frequently the result of fine drizzle. Haiphong, at the head of the Gulf of Tonkin, has an average of 53 days a year of fog, of which 38 days occur during December through February. Farther to the south, the frequency of fog decreases rapidly; most of the ports along the Annam Coast average between 7 and 11 days of fog per year.

Singapore, in the extreme southern portion of the area, records only 1 day a year with visibility less than 1.5 n. mi. which is not defined as fog. Along the Annam Coast the fog occurs mainly between 3:00 a. m. and 10:00 a. m. local time. The Winter Monsoon (northeast), whose flow over the Annam cordilleras is laminar, creates air turbulences on the Mekong plateaus and Mekong plain ground. This airflow creates distortions of the warm-air ground-boundary-layer and results in ground fog or ground layer condensation. This ground layer condensation, mostly in the morning, is not dense. However, sky re-radiation lowers the visibility considerably if the observer is above the ground layer in an airplane.

The many canals, rivers, and deltas reinforce the ground condensation to dense fog. The solar energy heats the ground and by 10:00 to 11:00 a. m., the rising temperature changes from fog to humidity.

2.3.2 Clouds

South Vietnam is a monsoon country with a wind system that is associated with the tremendous seasonal temperature and pressure variation over the interior of Asia. In winter, strong northeast winds blow down from the deserts, often carrying clouds of dust out over Vietnam. Cloudiness is strongest for Vietnam westward of the Annam cordilleras. The monsoon winds in Vietnam cause heavy cloudiness which is produced mainly by cumulus clouds. These cumulus clouds are generally dome-shaped on the upper surface with rounded protuberances and a flat base. In fine weather, the cumulus clouds appear in small masses which are bright on the sunny side and gray in the shadows; their vertical development is rather small. As the day advances, they may grow higher and have clearcut surfaces shaped like a cauliflower. After the cloud has developed, it may release heavy showers of rain, hail, or snow. The snow and hail change mostly to big, cool drops of rain by falling through warm, lower air.

In mountainous terrain, the violent vertical air currents are dangerous for aircraft. The clouds are white from above to almost black from below. In monsoons, their base height may be as low as 1000 ft, and their thickness about 40,000 ft, and in some cases more. The monsoon winds often cause the "levanter" or base clouds which have the same heights as the mountains of that particular area.

2.3.3 Winds

The monsoon winds in South Vietnam are caused by unequal air pressure over the land mass of Eurasia and the seas around it. In winter, the air over the central continent becomes very cold and dense which forms a center of high pressure. Over the surrounding oceans, the air is warmer and less dense. The Winter Monsoon is thus characterized by the outflowing of cold, dry air from the land masses to the oceans. In summer, reversed conditions exist. The Winter Monsoon period in Indochina lasts from mid-September until March. In all parts of the country local topographic variations change, or may even reverse the wind direction. The Summer Monsoon in Indochina commences in a less pronounced fashion. The wind velocity is generally 25 to 30 knots at 3000 ft. Figure 2-5 shows the directions of the monsoon winds over Indochina.

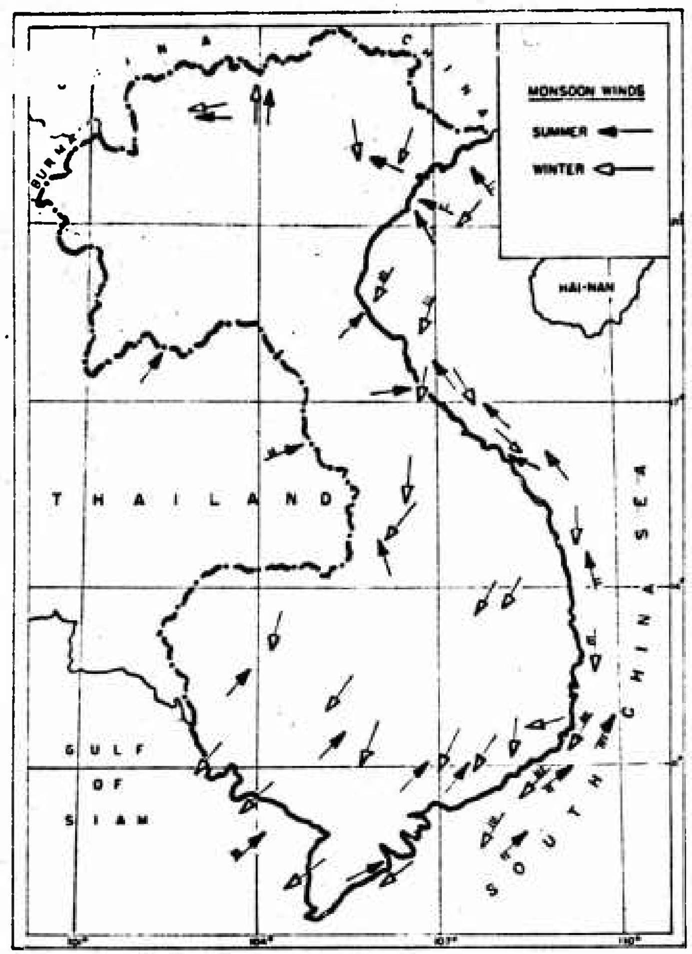


Figure 2-5 Directions of Monsoon Winds Over Indochina

2. 3. 4 Precipitation

The treatment of precipitation by the number of inches of rain accumulated per year is satisfactory from a theoretical viewpoint, but in practice it has a very limited meaning. For a proper evaluation, one must incorporate the following variations:

1. Duration of the rainy season
2. Lowest and highest average monthly temperature
3. Duration of the dry season
4. The monthly evaporation rate
5. The transport of moisture by trade winds or other winds
6. The natural storage or drainage of rain at ground level.

The wettest part of Indochina is in the southwest where the moisture-bearing southwest monsoon strikes the mountains bordering the coast of Cambodia. The Annam range generally receives a higher precipitation than the surrounding lowlands, in particular the frontal slopes of the Annam chain north of the Mekong lowlands. The mountains of northern Indochina receive a greater rainfall than do the lowlands, but less than those further south owing to their greater distance from the sea.

Rainfall on the Annam coast varies according to the direction of the coastline. The northeastward-facing coasts have an annual precipitation of over 80 in. but along the southern coast of Annam where both summer and winter monsoon winds parallel the coastline, the rainfall may be less than 40 in. per year. Figure 2-6 shows Indochina's annual rainfall.

2. 3. 5 Temperature

Most of the area is considered tropical and under maritime influences. The temperature and humidity are high throughout most of the year. The north part of Indochina is considered semitropical and experiences a greater range and variety of weather. Relative humidities are quite high and in combination with the high dew point. Temperatures give rise to favorable conditions for the formation of mildew.

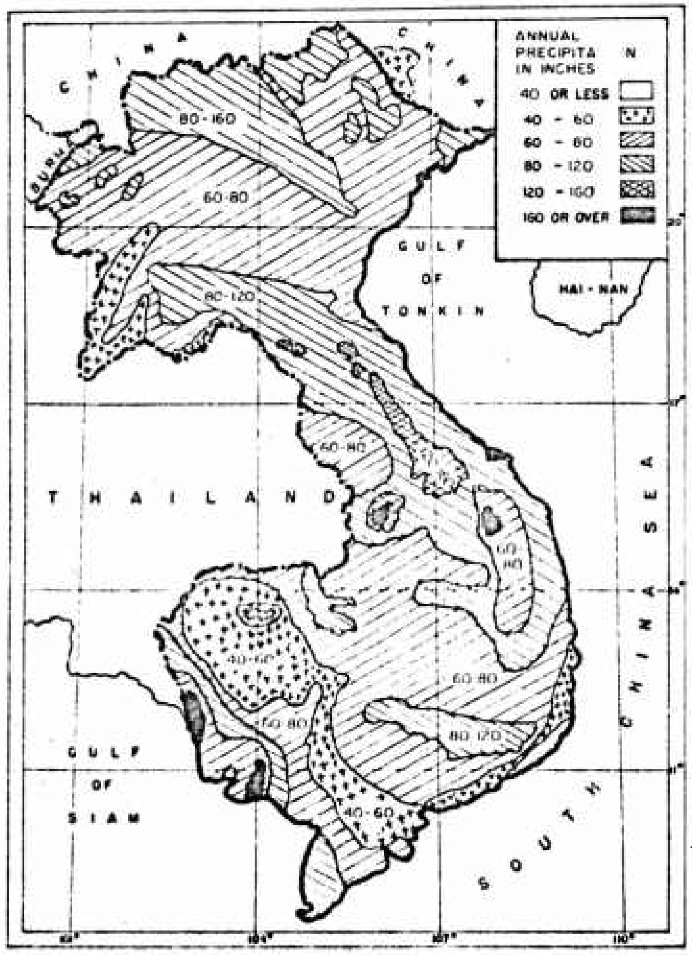


Figure 2-6 Annual Precipitation for Indochina

Land and sea breezes are felt close to the coast during transition periods and at other times when the monsoon is light. They are much more in evidence during the southwest monsoon which is not as strong or as persistent as the northeast monsoon. Land and sea breezes are well developed along the coast of Vietnam. The sea breeze usually begins at 10:00 a.m., reaches its maximum development in mid-afternoon, and dies down after sunset. The land breeze sets in before midnight and dies down shortly after sunrise. At the height of the monsoon season, the land and sea breezes reinforce or diminish the prevailing monsoon, according to whether they are in the same or the opposite direction of the monsoon.

Figures 2-7 through 2-10 show the surface temperatures of Indochina for January, April, July, and October, respectively. Figure 2-11 shows the absolute maximum temperature for the warmest month, April.

2.3.6 Typhoons

There are usually four or five typhoons per year occurring from July through October. The heavy resultant rains last two or three days and produce yearly rainfall maximums during August or September in areas exposed to typhoons.

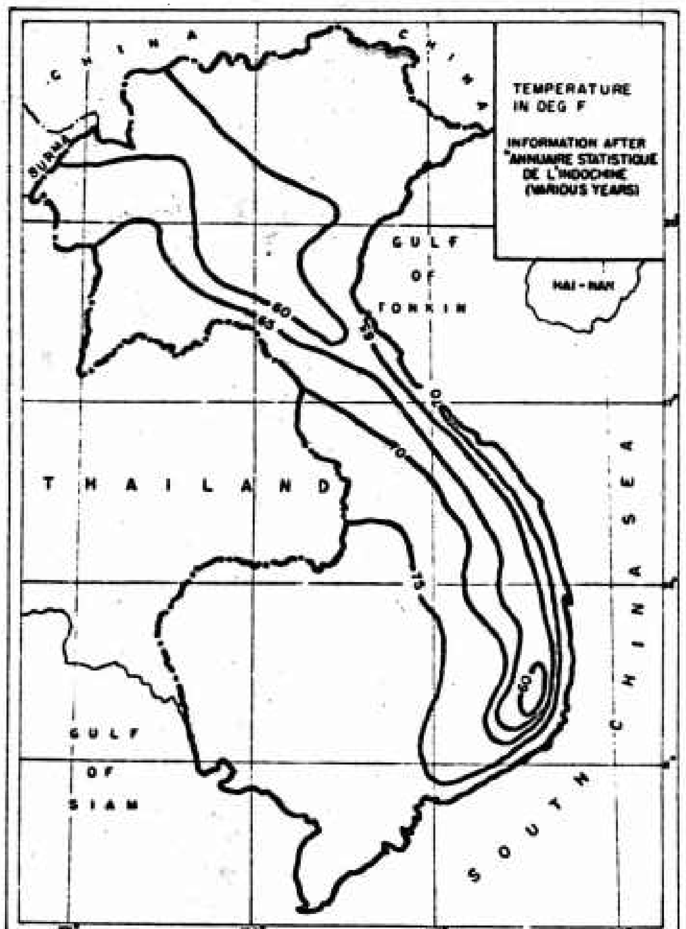


Figure 2-7 Surface Temperature of Indochina During January

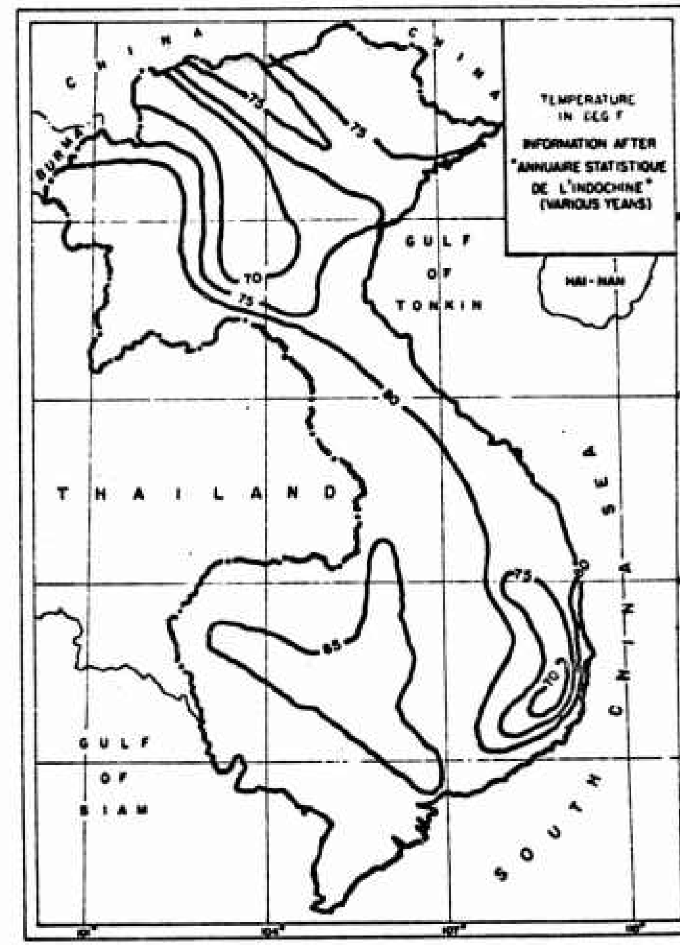


Figure 2-8 Surface Temperature of Indochina During April

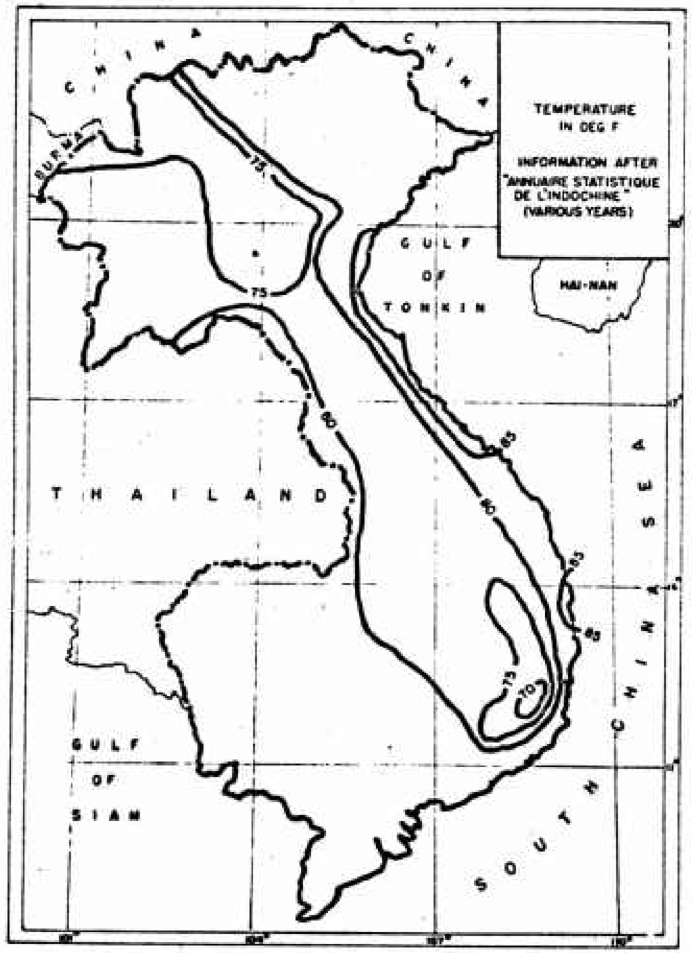


Figure 2-9 Surface Temperature of Indochina During July

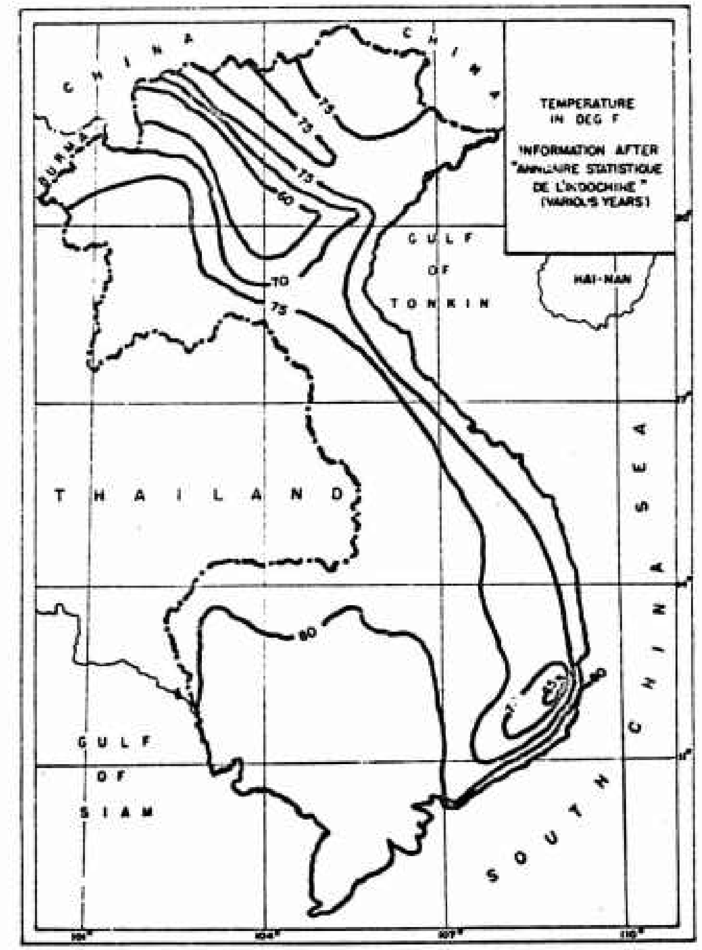


Figure 2-10 Surface Temperature of Indochina During October

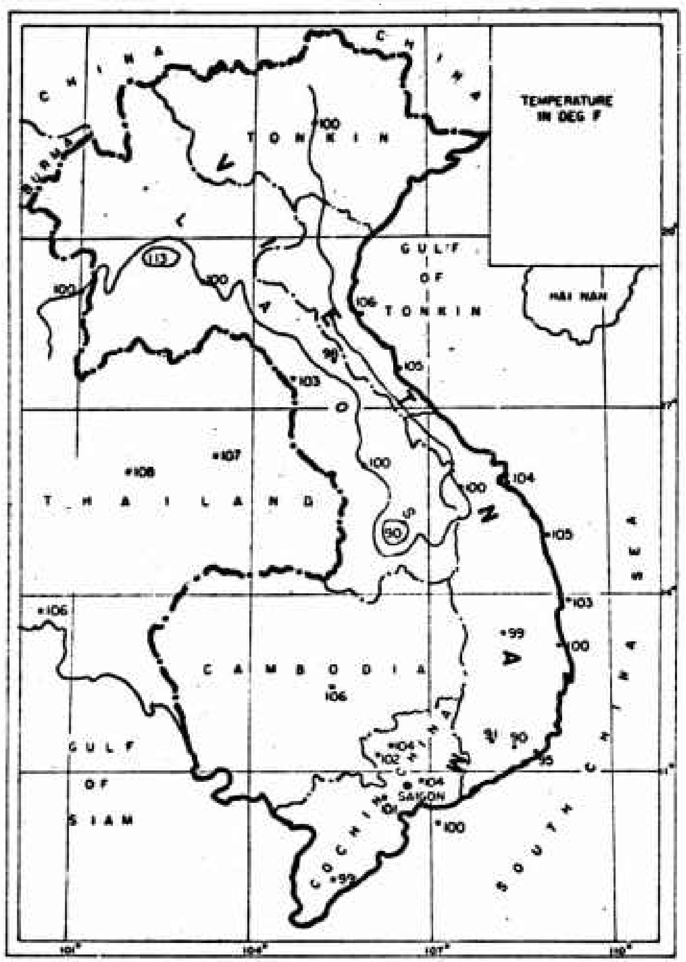


Figure 2-11 Absolute Maximum Temperature of Warmest Month (April) in Indochina

2.4 TOPOGRAPHY AND CLIMATE OF SOUTH VIETNAM

2.4.1 Topography

South Vietnam extends from approximately 8° 30' to 17°N latitude with the eastern borders open to the South China Sea and the Gulf of Siam. The country is predominantly mountainous except for the narrow coastal plains and the sections west of 107°E longitude (i.e., Siagon) where the Mekong River has formed an extensive delta system and the land is low-lying swamp and marshland.

2.4.2 Climate

The climate of South Vietnam is monsoonal in nature, although topography and trajectory of the air streams do much to modify the local weather. The monsoonal type climate has two distinct seasons—northeast (November to April) and southwest (June to October) monsoon—with two short transition periods—spring and autumn. South Vietnam is located entirely within the tropical latitudes, and temperatures are high the year around at all but the higher elevations. Generally, the highest temperatures occur in April except on the east coastal areas. Maximum temperatures approach the 90s; minimums are in the 70s. The northeast monsoon, as the designated cool season, is characterized by average temperatures of about only 10° less. Absolute extremes range from 31 to 108° F, depending on topography and ground cover. Humidities are high the year around. Maximum humidity values occur generally during the southwest monsoon with mean daily average of 80 to 90% over most of South Vietnam.

2.4.2.1 Seasons

Northeast Monsoon

From early November to mid-March, the relatively dry northeasterly airflow dominates. Clear to partly cloudy skies prevail over all regions except the eastern coastlands. The crachin affects the northern part of the eastern coastal regions with prolonged periods of widespread fog, low stratus type clouds, and light drizzle or rain. Except for the coastal areas, South Vietnam receives only 10 to 15% of its annual rain during this season. Visibilities are usually excellent with crystal clear air except for the areas affected by the crachin and in the valleys during the early morning when fog usually forms but dissipates rapidly after sunrise.

Spring Transition

By mid-March, the predominant northerly wind flow has weakened considerably and the air circulation becomes light and variable. The mean cloud amounts are low but increase as the season progresses toward the southwest monsoon season which begins by early May. The crachin no longer affects the eastern coastlands. Rainfall amounts, though not extreme, are greater than during the previous season. Thunderstorm activity increases as the season progresses and, at times, is severe in intensity. The climate becomes increasingly more oppressive as humidity and temperatures gradually rise to their maximum values in the southwest monsoon season. Visibilities are mostly unrestricted except during shower activity and occasional early morning fog.

Southwest Monsoon

By early May, moist southwest winds predominate and persist until early October. Mean cloud amounts average approximately 70 to 80% with convective type clouds predominating. Bases of low clouds are mostly 2000-3000 ft in extent. The weather is very oppressive and precipitation, mostly in the form of showers and thunderstorms, is frequent. Except during periods of precipitation and during morning fogs in the valleys, visibilities are fairly good although a persistent haze layer partially restricts surface visibilities. Regional variations of clouds and precipitation are largely dependent upon location and exposure to the moist southwesterly circulation.

Autumn Transition

From early October to early November, the weather gradually changes from the moist southwest monsoon season to the relatively dry northeast monsoon. Cloudiness and precipitation show a general decrease except for the eastern coastlands where the crachin begins to affect the area.

2.4.2.2 Special Weather Phenomena

Typhoons

An average of one or two typhoons per season affects South Vietnam with the maximum frequency occurring from October to January.

Crachin

The crachin is a prolonged period of widespread fog, low stratus clouds, and drizzle. This phenomenon occurs between October and April, mainly along the northeast coast. The average duration is two to three days, although it has been known to last for three weeks.

Wind of Laos

These winds occur during the southwest monsoon season along the eastern coast. The winds are hot and dry and sometimes flow strongly causing extreme evaporation along their path.

Land and Sea Breezes

Land and sea breezes of moderate intensity are common along the delta regions and coastal plains during the entire year. They often reverse the prevailing monsoon flow at low levels and cause local weather regimes which vary from the regional climate.

Thunderstorms

Most of the severe thunderstorms occur in the spring season, although thunderstorms may occur any time of the year.

2.4.2.3 Climatology Data for Specific Weather Stations

1. Ban Me Thuot

   Altitude: 1608 ft

   Also see Table 2-1.

2. Tourane (Da Nang)

   Altitude: 23 ft

   Also see Table 2-2.

3. Saigon

   Altitude: 32 ft

   Also see Table 2-3.

LOCATION: BAN ME THUOT (SOUTH VIETNAM)
Lat.: 12° 42'N - Long.: 108° 0.4' E - Alt.: 1608 Feet

TABLE 2-1

		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
TEMPERATURE (Degrees F)	Low	63	65	67	70	71	70	70	70	70	68	67	65
	Mean	80	85	89	90	88	85	84	84	83	82	81	79
	High	92	95	99	103	97	95	90	94	89	92	90	88
RELATIVE HUMIDITY (%)	Low												
	Mean	80	73	73	74	83	86	87	88	89	87	83	83
	High												
PRECIPITATION (Inches)	Low												
	Mean	0.1	0.3	0.7	4.6	9.6	9.8	9.5	14.2	11.8	7.9	3.3	1.3
	High												
No. of Days	Min												
	Mean	2	1	3	10	16	19	22	23	24	14	9	6
	Max												
CLOUD COVER (Tenths 0-10)													
CLOUD HEIGHT													

REMARKS:

LOCATION: TOURANE (SOUTH VIETNAM)
Lat.: 16° 02'N - Long.: 108° 11'E - Alt.: 23 Feet

TABLE 2-2

		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
TEMPERATURE (Degrees F)	Low	65	66	68	72	76	78	78	78	75	73	70	67
	Mean	72	74	78	84	89	90	90	90	85	80	77	73
	High	94	98	99	105	102	105	105	102	98	96	90	87
RELATIVE HUMIDITY (%)	Low												
	Mean	86	86	85	84	81	77	75	77	84	86	86	86
	High												
PRECIPITATION (Inches)	Low												
	Mean	4.2	1.8	0.9	1.3	2.6	2.8	2.5	4.7	15.7	23.3	15.1	8.7
	High												
No. of Days	Min												
	Mean	14	8	4	5	8	8	8	12	13	22	20	19
	Max												
CLOUD COVER (Tenths 0-10)													
CLOUD HEIGHT													

REMARKS:

TABLE 2-3

LOCATION: SAIGON (SOUTH VIETNAM)
Lat.: 10° 47'N - Long.: 106° 40'E - Alt.: 32 Feet

		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
TEMPERATURE (Degrees F)	Low	70	71	74	77	76	75	75	75	75	74	73	71
	Mean	89	91	93	94	92	89	88	89	88	88	87	87
	High	98	102	103	104	102	99	94	95	96	94	95	97
RELATIVE HUMIDITY (%)	Low												
	Mean	76	73	72	75	82	85	85	85	87	86	83	79
	High												
PRECIPITATION (Inches)	Low												
	Mean	0.6	0.2	0.4	2.1	8.7	12.5	11.6	10.5	13.3	10.4	4.9	2.3
	High												
No. of Days	Min												
	Mean	2	1	2	6	17	22	23	22	23	21	12	7
	Max												
CLOUD COVER (Tenths 0-10)													
CLOUD HEIGHT													

REMARKS:

2.4.3 Light Data

Extreme values of daylight for South Vietnam are:

1. June 22 9°N - 12 hours, 39 minutes

   17°N - 13 hours, 09 minutes

2. December 22 9°N - 11 hours, 33 minutes

   17°N - 11 hours, 07 minutes

Time of sunrise and sunset can be obtained approximately by dividing the duration of the day by two and subtracting it from or adding it to the time of local noon. Civil twilight begins approximately 25 minutes before sunrise and ends 25 minutes after sunset; nautical twilight lasts approximately 55 minutes.

2.5 TOPOGRAPHY AND CLIMATE OF NORTH VIETNAM

2.5.1 Topography

North Vietnam has several distinct types of topography. Extensive low deltas of the Red Song Ma and Song Ca Rivers extend along the coast and average 25 to 40 miles in width. West and north of the delta regions are the highlands which contain mountain ranges, low plateaus, and deep narrow river valleys. Most of the mountains are under 5000 ft in elevation. The narrow coastal areas are characterized by shallow lagoons, sand dunes, and flats. The steep eastern slopes of the Annamite Mountain lie along the border of Laos with occasional spurs of the mountains reaching to the sea.

2.5.2 Climate

The climate of North Vietnam is monsoonal in nature although topography and trajectory of the air streams do much to modify the local weather. Two major seasons—northeast and southwest monsoons—are separated by two short transition periods—spring and autumn.

2.5.2.1 Seasons

Northeast Monsoon

From mid-October to mid-March, the relatively cool northerly air flow predominates. Temperatures decrease from the beginning of the season, reaching their lowest annual value in January. Mean daily temperatures are in the high 60s or low 70s but because humidity is relatively high (year around), night temperatures are only 10 to 15° lower than daily maximums. The mountainous areas have appreciably lower humidities and subsequently lower temperatures during the night. Although this season is called the dry season (northern region receives 15% of its annual amount and the southern region about 35%), precipitation still occurs frequently. However, the total amount is relatively small because the majority of precipitation is in the form of light continuous drizzle or rain. Thunderstorm activity is at a minimum for the year. Typhoons occasionally affect this area. Cloudiness during the early part of the season is at a minimum but by December, extensive low cloudiness prevails over most of the area. Bases of low clouds are mostly about 1000 ft but bases below 1000 ft often

occur in the early mornings. Tops of low clouds are generally 6000 to 7000 ft and generally clear skies prevail above this altitude. Visibilities show a continual deterioration during the season with a pronounced increase in low visibilities in late December. These low visibilities are caused by low clouds and light drizzle, especially in the delta regions, coastal plains, and the eastern highlands. Fog is common in the early mornings in the valleys. Surface winds are predominantly north through east and speeds seldom exceed 15 knots, except over higher plateaus and mountain tops and along the immediate coast where a moderate land-sea breeze prevails.

Spring Transition Season

By late March, the northeast monsoon has weakened considerably and the circulation becomes weak and variable. Temperatures increase steadily toward the highest averages of the year in the southwest monsoon season which begins by mid-May. Humidity continues to be high, averaging over 75%. Although the frequency of rainfall shows little change, amounts of rainfall gradually increase as the season progresses. Light drizzle is replaced, as the season progresses, by the afternoon shower and thundershower type of weather. A marked decrease in frequency of low clouds occurs as the low persistent stratus type of clouds are replaced by convective type clouds. There is a minimum cloudiness at night and a maximum cloudiness during afternoon hours. Visibilities increase as the frequency of fog, low clouds, and persistent light rain decrease sharply. Surface winds are mostly light and variable.

Southwest Monsoon

By mid-May, hot moist southwesterly winds start to affect the area. Those winds continue until mid-September. Temperatures are the highest of the year with daily maximums over 90°F. Because of the high humidities, temperatures at night rarely fall below 70°F except at higher elevations. The lower atmosphere is always sultry and most oppressive. Precipitation is frequent with approximately 60 to 65% of the rainfall received during this season. Precipitation is mostly in the form of short, but intense, afternoon showers or thunderstorms. Flooding in the lowlands is common. Unusual phenomena include the "dry winds of Laos" which occur during this season. Mean cloud amounts average 75 to 80% with cumuliform type clouds predominating. Bases of low clouds are generally

2600 to 3000 ft. Cloud tops may reach 50,000 ft during the afternoon hours. Although unlimited visibilities are unusual because of the persistent haze layer, surface visibilities are fair except during periods of precipitation and occasional early morning fog.

Autumn Transition

The climate changes rapidly from mid-September to mid-October. In the north, both the amounts and frequency of precipitation decrease markedly and mean cloudiness drops to the lowest of the year. However, the southern part of South Vietnam has increased cloudiness and precipitation as the maximum rainfall is received during the autumn season. Temperatures throughout the area decrease uniformly. Except in the southern region, the end of autumn brings the minimum cloudiness and the lowest humidities of the year.

2.5.2.2 Special Weather Phenomena

Typhoons

An average of one or two typhoons per season affects North Vietnam with the maximum frequency occurring from August through early November.

Crachin

This phenomenon occurs mainly from December through May and affects primarily the northern delta regions and the east coastal lowland plains.

Winds of Laos

These winds occur during the southwest monsoon season and affect the extreme southern portion of North Vietnam.

Land and Sea Breezes

Land and sea breezes of moderate intensity are common along the delta regions and coastal plains during the entire year. They often reverse the prevailing monsoon flow at low levels and cause local weather regimes which vary from the regional climate.

Thunderstorms

Most of the severe thunderstorms occur in the spring season although thunderstorms may occur any time of the year.

2.5.2.3 Climatology Data for Specific Weather Stations

1. Chapa

   Altitude: 5379 ft

   Also see Table 2-4.

2. Lai-Chau

   Altitude: 610 ft

   Also see Table 2-5.

3. Lao-Kay

   Altitude: 305 ft

   Also see Table 2-6.

4. Son-La

   Altitude: 1975 ft

   Also see Table 2-7.

5. Van-Yen

   Altitude: 164 ft

   Also see Table 2-8.

6. Vinh

   Altitude: 20 ft

   Also see Table 2-9.

7. Yen-Bay

Altitude: 105 ft

Also see Table 2-10.

2.5.3 Light Data

Extreme values of daylight for North Vietnam are:

1. June 22 — 17°N - 12 hours, 39 minutes
   23°N - 13 hours, 35 minutes
2. December 22 — 17°N - 11 hours, 33 minutes
   23°N - 10 hours, 43 minutes

Civil twilight begins approximately 25 minutes before sunrise and ends 25 minutes after sunrise; nautical twilight lasts approximately 55 minutes.

TABLE 2-4

LOCATION: CHAPA (NORTH VIETNAM)

Latitude: 22°22'N – Longitude: 103°52'E – Altitude: 5,379 feet

		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
TEMPERATURE (Degrees F)	Low	42.4	44.3	50.0	53.3	59.5	61.6	63.7	62.0	59.5	54.3	50.0	46.4
	Mean	47.0	49.5	55.7	60.4	66.5	67.3	68.6	67.5	65.0	59.7	55.2	52.0
	High	51.8	55.2	61.6	67.7	73.2	72.5	73.7	73.2	70.5	65.4	60.0	57.5
RELATIVE HUMIDITY (%)	Low												
	Mean	78.0	84.0	86.0	80.0	79.0	86.5	86.0	87.0	90.0	88.5	87.0	82.5
	High												
PRECIPITATION (Inches)	Low	-	0.276	0.394	1.50	9.25	7.95	12.91	5.24	4.41	2.72	0.906	-
	Mean	1.69	3.15	4.25	7.09	15.67	13.46	20.12	19.17	13.50	7.56	4.65	1.77
	High	7.91	7.20	14.17	14.29	26.06	18.66	32.44	34.37	37.58	17.80	10.95	7.48
No. of Days	Min	0	3	2	6	11	13	16	15	11	8	5	0
	Mean	8	12	11	15	19	20	22	22	18	14	12	7
	Max	21	21	24	20	27	26	29	27	25	19	19	15
CLOUD COVER (Tenths 0-10)													
CLOUD HEIGHT													

REMARKS:

Relative Humidity (mean) = $\frac{10h + 16h}{2}$

LOCATION: LAI-CHAU (NORTH VIETNAM)

Latitude: 22°02'N – Longitude: 103°08'E – Altitude: 610 feet

TABLE 2-5

		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
TEMPERATURE (Degrees F)	Low												
	Mean												
	High												
RELATIVE HUMIDITY (%)	Low												
	Mean												
	High												
PRECIPITATION (Inches)	Low	–	2.76	0.787	3.19	8.82	9.49	12.56	11.54	5.39	–	0.197	–
	Mean	–	3.19	1.57	5.24	9.41	15.20	17.68	16.14	9.49	1.65	1.50	0.039
	High	–	3.66	2.95	7.13	9.96	18.27	21.06	24.57	12.91	3.35	3.62	0.039
No. of Days	Min	0	6	1	7	8	14	19	13	4	0	1	0
	Mean	0	6	2	8	10	18	21	15	10	2	3	1
	Max	0	7	3	9	14	21	23	16	14	4	7	1
CLOUD COVER (Tenths 0-10)													
CLOUD HEIGHT													

REMARKS:

LOCATION: LAO-KAY (NORTH VIETNAM)

Latitude: 22°30'N – Longitude: 103°57'E – Altitude: 305 feet

TABLE 2-6

		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
TEMPERATURE (Degrees F)	Low	56.5	57.5	63.0	68.3	73.2	76.0	76.0	75.6	73.7	69.4	62.6	57.2
	Mean	63.3	64.4	70.4	76.0	81.3	83.4	83.3	82.7	81.3	76.4	70.1	65.0
	High	70.4	71.0	77.5	83.5	89.4	90.5	90.3	90.0	88.6	83.4	77.7	72.7
RELATIVE HUMIDITY (%)	Low												
	Mean	77.5	76.5	75.5	75.0	74.0	76.5	78.5	78.5	77.0	78.0	78.5	76.5
	High												
PRECIPITATION (Inches)	Low	–	0.079	0.512	1.063	2.95	1.73	5.20	5.60	3.82	1.34	0.04	0.079
	Mean	0.669	1.46	2.36	4.21	9.25	8.74	12.05	13.82	9.49	4.49	2.52	1.06
	High	2.52	3.50	6.02	9.77	18.54	19.33	21.69	31.89	22.24	8.86	6.97	4.13
No. of Days	Min	1	1	3	4	8	8	12	10	7	6	2	1
	Mean	4	7	10	13	15	16	19	18	14	11	9	5
	Max	11	11	18	21	23	22	24	25	22	19	16	11
CLOUD COVER (Tenths 0-10)		8.2	8.0	7.5	6.7	6.2	7.0	7.0	6.7	6.5	7.2	7.5	7.2
CLOUD HEIGHT													

REMARKS:

Relative Humidity (mean) $= \frac{10h + 16h}{2}$

LOCATION: SON-LA (NORTH VIETNAM)

Latitude: 21°20'N – Longitude: 103°54'E – Altitude: 1,975 feet

TABLE 2-7

		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
TEMPERATURE (Degrees F)	Low												
	Mean												
	High												
RELATIVE HUMIDITY (%)	Low												
	Mean												
	High												
PRECIPITATION (Inches)	Low	–	–	0.433	3.31	3.70	3.90	2.99	4.37	2.60	–	–	–
	Mean	0.906	1.46	1.34	4.61	7.20	11.26	11.77	9.92	7.05	2.13	2.52	0.276
	High	3.07	2.01	2.64	6.34	11.30	16.89	16.34	15.20	13.27	3.82	9.84	1.06
No. of Days	Min	0	0	2	6	10	7	13	14	5	0	0	0
	Mean	2	5	4	8	14	15	19	18	14	5	4	1
	Max	4	9	7	13	18	22	23	21	20	10	7	3
CLOUD COVER (Tenths 0-10)													
CLOUD HEIGHT													

REMARKS:

LOCATION: VAN-YEN (NORTH VIETNAM)

Latitude: 21°04'N – Longitude: 104°42'E – Altitude: 164 feet

TABLE 2-8

		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
TEMPERATURE (Degrees F)	Low												
	Mean												
	High												
RELATIVE HUMIDITY (%)	Low												
	Mean												
	High												
PRECIPITATION (Inches)	Low	–	1.18	–	1.26	6.54	5.51	11.77	4.72	2.87	–	–	–
	Mean	0.118	1.50	0.59	4.02	7.53	6.46	14.80	6.85	5.83	2.99	0.354	0.551
	High	0.157	1.89	1.06	6.69	8.70	7.48	16.61	8.15	10.67	6.89	0.905	1,062
No. of Days	Min	0	6	0	10	14	12	13	15	8	1	0	0
	Mean	2	7	4	11	14	13	18	16	11	5	3	3
	Max	3	9	5	12	14	14	21	18	16	8	7	6
CLOUD COVER (Tenths 0-10)													
CLOUD HEIGHT													

REMARKS:

LOCATION: VINH (NORTH VIETNAM)
Lat. : 18° 40'N - Long. : 105° 40'E - Alt. : 20 Feet

TABLE 2-9

		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
TEMPERATURE (Degrees F)	Low	59	61	64	70	75	78	78	78	75	71	66	62
	Mean	70	70	74	83	90	94	94	93	87	83	77	72
	High	95	96	102	104	106	108	106	103	103	99	97	89
RELATIVE HUMIDITY (%)	Low												
	Mean	90	91	91	88	83	74	75	78	86	86	87	87
	High												
PRECIPITATION (Inches)	Low												
	Mean	2.2	1.8	1.9	2.4	5.1	4.7	6.1	6.0	16.5	13.7	7.5	3.1
	High												
No. of Days	Min												
	Mean	12	12	12	9	10	7	9	9	14	14	13	12
	Max												
CLOUD COVER (Tenths 0-10)													
CLOUD HEIGHT													

REMARKS:

LOCATION: YEN-BAY (NORTH VIETNAM)
Latitude: 21°42'N - Longitude: 104°52'E - Altitude: 105 feet

TABLE 2-10

		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
TEMPERATURE (Degrees F)	Low												
	Mean												
	High												
RELATIVE HUMIDITY (%)	Low												
	Mean												
	High												
PRECIPITATION (Inches)	Low	-	-	1.30	1.38	3.90	5.59	4.72	2.91	2.72	0.315	0.236	-
	Mean	1.26	2.05	3.23	4.06	11.34	13.78	15.24	16.22	9.49	5.94	2.20	1.10
	High	2.91	4.29	7.64	7.60	34.21	22.83	25.79	32.91	20.71	13.58	6.85	2.95
No. of Days	Min	0	0	0	7	5	8	8	10	2	1	2	0
	Mean	9	11	14	14	13	12	15	16	10	7	6	6
	Max	24	20	26	25	21	21	23	22	18	11	17	14
CLOUD COVER (Tenths 0-10)													
CLOUD HEIGHT													

REMARKS:

2.6 TOPOGRAPHY AND CLIMATE OF LAOS

2.6.1 Topography

Landlocked Laos extends from approximately 14° to 22°N latitude, with the greater part covered by monsoon forest and tropical rainforests. Most of the western boundary is composed of the narrow Mekong River lowlands. The northern half consists chiefly of plateaus between 2000 and 4000 ft in altitude and mountains with the highest peaks being 7000 to 9200 ft high. The southern half of Laos is composed of the Annamite Mountains in the east, the low-lying valley floor ajoining the Mekong River in the west, alluvial plains and low hills near the center, and the Bolovens Plateau in the extreme south. The Annamite Mountain ridge is almost perpendicular to the two monsoonal airflows and exerts a marked influence on the climate.

2.6.2 Climate

The climate is tropical monsoonal in nature with moist summers and relatively dry winters. Temperatures are high the year around. The two seasons the southwest monsoon and the northeast monsoon are separated by two rather short transitional periods-spring and autumn intermonsoon periods.

2.6.2.1 Seasons

Northeast (Winter) Monsoons

From mid-October to mid-March, the relatively cool and dry northerly air flow predominates and gives the most comfortable weather of the year. Temperatures range from afternoon maximums in the 80s to night minimums in the 60s. At elevations of 2000 to 4000 ft, temperatures average 10° cooler and extreme minimums near freezing can be expected at the highest elevations with a humidity of 60 to 70%. Cloudiness is at a minimum for the year with clear skies occuring 60 to 70% of the time. Cumulus clouds frequently form during the afternoons but seldom constitute a ceiling. Precipitation is rare with less than 10% of the annual rainfall occurring and most areas receiving less than 1 in. per month. Visibilities are usually excellent with the air crystal clear. However, early morning fog or low stratus clouds are experienced frequently in the deep narrow river valleys, but such fogs usually dissipate by late morning. Surface winds are predominantly northeasterly, terrain permitting. Winds are usually calm during evenings and mornings with daytime winds averaging 10 to 15 knots.

Spring Intermonsoon

By mid-March, the northeast flow no longer dominates the area and circulation is weak and variable prior to the onset of the monsoon by mid-May. Temperatures increase to their maximum values of the year with daily temperatures in the 90s (over 100°F is common) and daily minimums in the high 60s at the lower elevations. Higher elevations are appreciably cooler. Humidities are low but increase as the season progresses and by May the climate is very oppressive. Cloud amounts are still low and skies remain relatively clear. Rainfall amounts, although not extreme, are greater than during the previous season as cumulus type clouds often develop into afternoon showers and thunderstorms, especially during the latter part of the season. Thunderstorms are at times severe and are associated with low ceilings, torrential rainfall, and gale force winds which last for one to two hours at a time. Visibilities become more restricted during the early part of the season as a result of grass fires which give a persistent smoke layer aloft at 8000-9000 ft. During the latter part of the season, showers tend to wash the atmosphere and wet down the ground, thus reducing the source of air contaminants. Surface winds are mostly light and variable.

Southwest (Summer) Monsoon

By mid-May, the moist southwest air flow predominates and gives the area extensive low cloudiness, heavy rainshowers, and thunderstorms. Temperatures remain high with daily maximums above 85°F. The humidity is high and night temperatures seldom fall below 65°F, except at higher elevations. The atmosphere is always sultry. Extensive cloudiness prevails with a mean sky cover of 75 to 95%. Ceilings below 1000 ft are common in early morning hours but rise to 2000-3000 ft during the day with cumulus and cumulonimbus type clouds predominating. Approximately 70% of the annual rainfall occurs during this season, mostly in the form of short but intense showers or thunderstorms during the late afternoon hours. Over 7 in. of rain in a 24-hr period is not unusual. Most of the roads are impassable and flooding in the lowlands is common. Two days without precipitation is remarkable. Visibilities are often restricted by a persistent haze layer. Early morning fog is common, especially in the mountainous sections, but dissipates rapidly after sunrise. Surface winds are predominantly southwesterly with the majority of reported wind speeds below 10 knots. Terrain in this relatively rugged country has a pronounced effect on the local surface winds.

Autumn Intermonsoon

From mid-September to mid-October, the weather gradually changes from the hot, moist, cloudy, southwest monsoon season to the relatively warm, dry, clear northeast monsoon season. Cloudiness, precipitation, temperatures, and humidity all show a gradual decrease and visibilities improve greatly as the winds gradually shift to a northerly direction.

2.6.2.2 Special Weather Phenomena

Typhoons

Laos is too far south and west to be much affected by typhoons originating in the Western Pacific Ocean and the South China Sea. The effect of these typhoons is usually to produce increased cloudiness and precipitation in Laos.

Thunderstorms

Thunderstorms of violent intensity can occur at any time of the year, but generally are most common during the spring transition season. Local damage has been caused by the torrential rainfall, gale force winds of 50 to 80 knots, and hailstones as large as 2 in. in diameter. The average duration of thunderstorms is one hour.

2.6.2.3 Climatology Data for Specific Weather Stations

1. Attopeu

   Altitude: 354 ft

   Also see Table 2-11

2. Luang Prabang

   Altitude: 1148 ft

   Also see Table 2-12

3. Nape

   Altitude: 1932 ft

   Also see Table 2-13

4. Phong Saly

   Altitude: 4920 ft

   Also see Table 2-14

5. Savannakhet, Seno

   Altitude: 459 ft

   Also see Table 2-15

6. Tchepone

   Altitude: 607 ft

   Also see Table 2-16

7. Thakhet

   Altitude: 443 ft

   Also see Table 2-17

8. Vientiane

   Altitude: 532 ft

   Also see Table 2-18

9. Xieng, Khounang

   Altitude: 3770 ft

   Also see Table 2-19

TABLE 2-11

LOCATION: ATTOPEU (LAOS)

Latitude: 14°54'N - Longitude: 106°45'E - Altitude: 354 feet

		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
TEMPERATURE (Degrees F)	Low												
	Mean												
	High												
RELATIVE HUMIDITY (%)	Low												
	Mean												
	High												
PRECIPITATION (Inches)	Low	-	-	0.079	0.394	1.61	4.84	7.05	8.23	10.47	2.56	-	-
	Mean	0.157	0.512	1.42	2.72	10.87	13.86	19.84	21.30	15.98	6.61	1.22	0.236
	High	1.30	3.58	4.09	6.93	20.28	34.69	32.44	37.12	32.28	15.67	4.33	1.46
No. of Days	Min	0	0	1	1	5	13	10	9	10	3	0	0
	Mean	0	1	3	5	13	17	22	24	20	10	4	1
	Max	3	4	6	11	18	26	31	31	30	21	8	4
CLOUD COVER (Tenths 0-10)													
CLOUD HEIGHT													

REMARKS:

TABLE 2-12

LOCATION: LUANG PRABANG (LAOS)

Latitude: 19°58'N - Longitude: 102°08'E - Altitude: 1,148 feet

		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
TEMPERATURE (Degrees F)	Low	56.3	55.3	65.2	69.0	72.8	74.7	74.3	73.6	73.2	69.4	64.2	59.5
	Mean	69.3	74.0	78.5	82.4	84.6	84.1	82.8	82.2	82.7	80.0	74.4	70.7
	High	82.0	89.6	93.5	96.0	96.0	93.5	91.0	90.5	92.3	90.0	85.3	80.8
RELATIVE HUMIDITY (%)	Low	23	24	-	30	40	38	53	45	49	35	40	47
	Mean	69.5	62.0	58.0	58.0	62.5	69.0	74.0	78.0	74.0	72.5	71.5	71.5
	High	99.2	95.3	-	93.2	96.2	99.0	99.9	97.4	97.7	97.2	96.2	99.3
PRECIPITATION (Inches)	Low	-	-	0.079	0.433	0.827	0.866	2.68	2.83	0.945	0.236	-	-
	Mean	0.787	0.51	1.30	4.41	5.90	6.34	9.06	12.16	6.54	3.29	1.22	0.314
	High	5.51	2.36	3.58	12.36	13.11	15.20	19.09	21.30	14.41	9.76	4.57	1.53
No. of Days	Min	0	0	1	3	3	4	6	12	3	1	0	0
	Mean	2	2	4	8	13	13	17	19	12	6	4	1
	Max	10	8	9	16	22	16	25	27	21	15	9	4
CLOUD COVER (Tenths 0-10)		4.8	2.8	2.8	3.2	4.5	5.2	6.0	6.5	4.5	4.0	4.5	4.5
CLOUD HEIGHT													

REMARKS: Relative Humidity (mean) = $\frac{10h + 16h}{2}$

LOCATION: NAPE (LAOS)

Latitude: 18°18'N - Longitude: 105°04'E - Altitude: 1,932 feet

TABLE 2-13

		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
TEMPERATURE (Degrees F)	Low												
	Mean												
	High												
RELATIVE HUMIDITY (%)	Low												
	Mean												
	High												
PRECIPITATION (Inches)	Low	-	-	0.551	1.85	1.89	3.90	8.39	10.31	1.85	0.315	0.079	-
	Mean	0.157	1.61	2.32	4.80	6.38	12.48	16.22	18.39	9.53	5.55	0.787	0.512
	High	0.906	8.62	7.24	7.56	12.13	25.98	26.14	32.87	21.69	14.84	2.17	1.18
No. of Days	Min	0	0	2	4	10	16	16	22	4	1	1	0
	Mean	4	5	5	9	17	21	23	26	13	9	6	7
	Max	10	10	9	20	24	25	31	29	21	15	12	17
CLOUD COVER (Tenths 0-10)													
CLOUD HEIGHT													

REMARKS:

LOCATION: PHONG SALY (LAOS)

Latitude: 21°42'N – Longitude: 102°06'E – Altitude: 4,920 feet

TABLE 2-14

		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
TEMPERATURE (Degrees F)	Low												
	Mean												
	High												
RELATIVE HUMIDITY (%)	Low												
	Mean												
	High												
PRECIPITATION (Inches)	Low	–	–	0.512	0.630	2.83	5.83	10.39	8.23	2.60	0.748	–	–
	Mean	0.669	0.984	1.93	3.94	7.13	10.28	15.55	14.80	6.30	3.07	1.81	1.38
	High	2.80	3.23	4.53	5.79	13.78	15.98	19.69	21.61	15.51	6.38	3.78	4.4
No. of Days	Min	0	0	2	3	6	13	15	12	6	4	0	0
	Mean	2	3	5	9	12	20	21	21	11	8	5	2
	Max	8	7	8	14	17	28	25	28	19	13	7	7
CLOUD COVER (Tenths 0-10)													
CLOUD HEIGHT													

REMARKS:

TABLE 2-15

LOCATION: SAVANNAKHET, SENO (LAOS)

Latitute: 16°33'N - Longitude: 104°44'E - Altitude: 459 feet

		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
TEMPERATURE (Degrees F)	Low	57	63	68	73	75	76	75	75	74	68	64	60
	Mean	86	89	93	96	94	91	88	88	88	87	86	85
	High	102	102	108	107	105	98	95	96	95	97	96	97
RELATIVE HUMIDITY (%)	Low												
	Mean	77	75	72	72	81	84	86	86	88	81	79	77
	High												
PRECIPITATION (Inches)	Low	-	0.118	0.276	7.80	6.65	9.61	7.52	10.87	3.03	4.25	-	-
	Mean	-	2.09	0.512	7.80	8.46	10.20	8.46	12.76	5.04	5.00	0.354	-
	High	-	4.02	0.709	7.83	10.31	10.83	9.37	10.71	7.09	5.75	0.669	-
No. of Days	Min	0	2	2	8	7	11	10	13	6	6	0	0
	Mean	0	3	3	11	15	14	16	15	10	9	1	0
	Max	0	4	3	14	24	17	22	18	13	10	1	0
CLOUD COVER (Tenths 0-10)													
CLOUD HEIGHT													

REMARKS:

TABLE 2-16

LOCATION: TCHEPONE (LAOS)

Latitude: 16°41'N - Longitude: 106°14'E - Altitude: 607 feet

		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
TEMPERATURE (Degrees F)	Low	59.4	62.4	67.4	72.5	74.4	75.7	75.4	74.3	73.4	70.8	69.5	62.1
	Mean												
	High	76.4	78.5	84.9	86.7	86.4	83.2	81.6	82.5	83.4	82.9	78.5	74.8
RELATIVE HUMIDITY (%)	Low	92.5	89.9	92.7	93.3	92.9	93.4	94.1	94.0	96.4	94.6	91.3	89.7
	Mean												
	High	-	-	-	-	-	-	-	-	-	-	-	-
PRECIPITATION (Inches)	Low	-	-	-	0.472	2.13	3.31	7.20	8.39	1.34	-	-	-
	Mean	0.197	0.827	1.26	3.46	5.59	11.06	18.98	17.91	11.81	6.26	0.630	0.039
	High	1.69	4.13	3.03	5.77	10.98	28.43	54.57	31.93	24.41	18.15	2.17	0.236
No. of Days	Min	0	0	0	1	5	5	9	6	2	0	0	0
	Mean	0	2	2	4	8	12	15	15	8	4	1	0
	Max	1	5	3	7	14	21	23	25	15	11	5	1
CLOUD COVER (Tenths 0-10)													
CLOUD HEIGHT													

REMARKS:

LOCATION: THAKHET (LAOS)

Latitude: 17°23'N - Longitude: 104°48'E - Altitude: 443 feet

TABLE 2-17

		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
TEMPERATURE (Degrees F)	Low												
	Mean												
	High												
RELATIVE HUMIDITY (%)	Low												
	Mean												
	High												
PRECIPITATION (Inches)	Low	-	0.984	-	2.28	5.04	9.09	12.24	13.31	11.38	1.06	-	-
	Mean	-	1.54	0.709	3.58	9.84	12.48	22.64	19.41	15.12	2.60	0.157	0.472
	High	-	2.44	2.13	4.96	14.65	16.18	28.11	22.87	21.77	3.90	0.315	1.38
No. of Days	Min	0	1	0	4	12	15	13	19	11	3	0	0
	Mean	0	4	1	7	15	18	22	23	15	4	2	1
	Max	0	5	3	10	18	19	29	25	18	6	4	3
CLOUD COVER (Tenths 0-10)													
CLOUD HEIGHT													

REMARKS:

LOCATION: VIENTIANE (LAOS)

Latitute: 17°57'N – Longitude: 102°34'E – Altitude: 532 feet

TABLE 2-18

		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
TEMPERATURE (Degrees F)	Low	58	63	67	72	75	76	75	75	74	71	66	59
	Mean	83	87	91	93	90	89	87	87	87	87	85	83
	High	95	99	104	103	102	99	97	98	95	94	95	95
RELATIVE HUMIDITY (%)	Low												
	Mean	77	75	72	74	82	85	86	86	86	82	79	78
	High												
PRECIPITATION (Inches)	Low	–	–	0.039	0.276	3.11	4.02	4.57	8.62	3.90	–	–	–
	Mean	0.315	0.551	1.69	3.74	10.67	12.40	9.88	12.52	11.06	3.58	u. 59	0.157
	High	2.56	2.44	5.28	12.95	17.28	19.65	16.65	18.43	30.59	12.20	3.74	0.945
No. of Days	Min	0	0	1	1	5	8	9	9	7	0	0	0
	Mean	1	2	4	6	13	16	15	17	14	6	1	1
	Max	4	8	10	12	19	22	22	26	24	17	5	3
CLOUD COVER (Tenths 0-10)													
CLOUD HEIGHT													

REMARKS:

TABLE 2-19

LOCATION: XIENG - KHOUNANG (LAOS)

Latitude: 19°28'N - Longitude: 103°08'E - Altitude: 3770 feet

		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
TEMPERATURE (Degrees F)	Low	47	51	55	60	64	66	66	66	64	60	55	47
	Mean	74	78	82	82	82	81	79	79	80	78	74	71
	High	86	90	91	92	89	88	87	87	88	87	87	84
RELATIVE HUMIDITY (%)	Low												
	Mean												
	High												
PRECIPITATION (Inches)	Low	-	-	0.394	1.57	4.17	6.22	13.90	13.31	7.40	0.630	0.236	-
	Mean	0.433	0.906	0.827	5.83	10.51	12.91	15.94	14.92	12.09	5.87	1.06	0.236
	High	1.30	1.81	1.57	10.75	18.90	21.93	19.33	17.05	19.84	12.20	2.48	0.472
No. of Days	Min	0	0	2	7	17	19	25	22	19	4	5	0
	Mean	5	4	3	14	22	23	27	26	23	13	7	4
	Max	19	12	4	17	27	29	29	29	27	22	13	10
CLOUD COVER (Tenths 0-10)													
CLOUD HEIGHT													

REMARKS:

2.6.3 Light Data

Extreme values of light data for Laos are:

1. June 22 — 14°N - 12 hours, 59 minutes
   22°N - 13 hours, 29 minutes
2. December 22 — 14°N - 11 hours, 14 minutes
   22°N - 10 hours, 47 minutes

Civil twilight begins approximately 24 minutes before sunrise and ends 24 minutes after sunset; nautical twilight lasts approximately 55 minutes.

2.7 TOPOGRAPHY AND CLIMATE OF THAILAND

2.7.1 Topography

Thailand, extending from approximately 6° to slightly above 20° north latitude, is composed of a variety of terrain features. The northwest section is composed of a mountainous area with elevations ranging generally from 500 to over 4000 ft. The mountains extend southward along the western border and form the backbone of the valley peninsula. A plain and delta form an elongated lowland in the west central region; the eastern section is composed of a vast, low, inhospitable plateau. A continuous elevated region separates these two lowland regions. The coast is composed mostly of a narrow lowland area with many indentations and islands lying along its shore.

2.7.2 Climate

Thailand displays mostly a tropical monsoon type of climate. Characteristics are high temperatures and humidity throughout the year and seasonal variations in precipitation and cloudiness. Topography produces considerable regional climatic variations. The four climatic seasons are referred to as: Northeast Monsoon, Spring Intermonsoon, Southwest Monsoon, and Autumn Intermonsoon.

2.7.2.1 Seasons

Northeast Monsoon

November through February is the most comfortable time of the year. This is designated as the cool season; however, maximum temperatures are still in the high 80s and low 90s. Relatively dry northeast winds prevail. Except in the southern peninsula section which receives substantial amounts of precipitation and clouds, the rest of Thailand has clear and fine weather. Generally, skys are clear at night; cumulus and altocumulus type clouds, whose bases are above 2000 ft, predominate during late morning and afternoon hours. Except for frequent early morning fog in the valleys, visibilities are mostly unrestricted.

Spring Intermonsoon

March and April are the hottest months of the year with mean daily maximum temperatures in the high 90s. Night temperatures seldom go below 70°F. Surface winds are light and variable except in coastal regions where moderate land-sea breezes occur. Sky conditions are similar to that of the Northeast Monsoon season. Rainfall amounts are small and relative humidity is at its lowest. Thunderstorms, sometimes violent in intensity, occasionally occur over the interior. Except for the common early morning fog in the valleys, visibilities are mostly excellent with the air crystal clear.

Southwest Monsoon

During May through September, a warm, moist southwest wind prevails and brings the area extensive cloudiness and precipitation. A normal diurnal cloud pattern is scattered low clouds at sunrise, increasing in amounts during the day and becoming overcast by the afternoon with bases at 2000 to 2500 ft. Ceilings below 1000 ft are rare. Extensive medium and high level clouds prevail throughout the season with little diurnal variation. Frequent precipitation is mostly in the form of afternoon showers or thunderstorms. Severe type thunderstorms (average duration one hour) occasionally occur. Temperatures remain high and, with the higher humidities, the climate is very oppressive. Nights remain warm and sultry. Except during rainfall, visibilities continue to be excellent.

Autumn Intermonsoon

From mid-September to November, the weather gradually changes from the hot, moist, cloudy, Southwest Monsoon season to the relatively warm, dry, fair, Northeast Monsoon season.

2.7.2.2 Special Weather Phenomena

Thailand is only infrequently affected by the tropical storms which are common to the other parts of southwest Asia. An average of one every several years affects the lower east coast of the peninsula. Other widespread destructive weather phenomena are rare, although the lowlands are subject to flooding during the wet Southwest Monsoon season. Local violent, destructive thunderstorms may occur several times during the year, mostly during April through June, over the interior regions.

2.7.2.3 Climatology Data for Specific Weather Stations

1. Bangkok

   Altitude 10 ft

   Also see Table 2-20

2. Muang Ubon

   Altitude 404 ft

   Also see Table 2-21

3. Nakhon Ratchasima-

   Altitude 945 ft

   Also see Table 2-22

4. Udon-Thani

   Altitude 584 ft

   Also see Table 2-23

TABLE 2-20

LOCATION: BANGKOK (THAILAND)
Lat.: 13° 45'N - Long.: 100° 31'E - Alt.: 10 Feet

		Jan	Feb	Mar	Apr.	May	June	July	Aug	Sept	Oct	Nov	Dec
TEMPERATURE (Degrees F)	Low	68	71	74	76	76	76	75	75	75	74	72	67
	Mean	91	92	97	94	96	89	90	90	90	90	89	87
	High	100	102	104	107	104	99	94	95	97	98	98	97
RELATIVE HUMIDITY (%)	Low	48	50	48	49	57	62	61	61	64	64	62	53
	Mean												
	High	95	95	94	91	94	95	95	95	97	97	97	95
PRECIPITATION (Inches)	Low												
	Mean	0.4	0.7	1.5	1.9	5.5	5.4	6.5	7.0	11.1	10.0	3.0	0.4
	High												
No. of Days	Min												
	Mean	1	1	2	3	7	9	10	10	13	12	4	1
	Max												
CLOUD COVER (Tenths 1-10)													
CLOUD HEIGHT													

REMARKS:

TABLE 2-21

LOCATION: MUANG UBON (THAILAND)
Lat.: 15° 14'N - Long.: 104° 52'E - Alt.: 404 Feet

		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
TEMPERATURE (Degrees F)	Low	62	65	71	74	75	75	75	75	74	72	68	63
	Mean	88	91	[illegible]	95	92	90	89	88	87	87	87	85
	High	96	99	103	105	100	99	97	94	94	94	93	94
RELATIVE HUMIDITY (%)	Low	55	42	40	45	55	64	68	70	78	63	62	60
	Mean												
	High	93	96	94	92	92	93	95	96	96	96	97	97
PRECIPITATION (Inches)	Low												
	Mean	–	0.3	0.9	2.9	6.9	8.0	10.4	13.0	13.2	5.6	1.2	0.1
	High												
No. of Days	Min												
	Mean	–	1	2	5	12	13	15	15	16	7	2	1
	Max												
CLOUD COVER (Tenths 1-10)													
CLOUD HEIGHT													

REMARKS:

LOCATION: NAKHON RATCHASIMA, KORAT (THAILAND)
Lat.: 14° 58'N – Long.: 102° 07'E – Alt.: 594 Feet

TABLE 2-22

		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
TEMPERATURE (Degrees F)	Low	60	65	71	73	74	75	74	74	73	71	67	61
	Mean	90	95	98	97	94	92	92	91	90	89	89	87
	High	100	104	106	108	102	100	99	101	101	96	100	99
RELATIVE HUMIDITY (%)	Low	41	42	42	49	58	60	58	59	65	65	69	52
	Mean												
	High	94	89	90	91	94	92	93	94	96	97	95	95
PRECIPITATION (Inches)	Low												
	Mean	0.3	1.3	1.7	3.7	7.3	4.6	4.5	5.7	8.0	6.4	1.6	0.1
	High												
No. of Days	Min												
	Mean	1	3	5	8	14	11	13	14	17	11	3	1
	Max												
CLOUD COVER (Tenths 0-10)													
CLOUD HEIGHT													

REMARKS:

LOCATION: UDON-THANI (THAILAND)
Lat.: 17° 26'N – Long.: 102° 46'E – Alt.: 584 Feet

TABLE 2-23

		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
TEMPERATURE (Degrees F)	Low	57	61	68	73	75	76	75	75	74	71	67	56
	Mean	88	90	96	96	94	92	91	90	90	89	89	86
	High	98	102	105	109	105	102	100	98	99	96	93	97
RELATIVE HUMIDITY (%)	Low	47	46	43	50	61	66	67	69	68	61	55	51
	Mean												
	High												
PRECIPITATION (Inches)	Low												
	Mean	0.3	0.7	1.7	4.5	9.4	8.3	7.8	9.3	10.2	3.9	0.8	0.2
	High												
No. of Days	Min												
	Mean	1	3	5	8	14	16	16	15	16	6	2	–
	Max												
CLOUD COVER (Tenths 0-10)													
CLOUD HEIGHT													

REMARKS:

2.7.3 Light Data

1. June 22 — $7^{0}N$ - 12 hours, 33 minutes

   $20^{0}N$ - 13 hours, 21 minutes

2. December 22 — $7^{0}N$ - 11 hours, 43 minutes

   $20^{0}N$ - 10 hours, 55 minutes

Civil twilight begins approximately 25 minutes before sunrise and ends 25 minutes after sunset throughout the year.

2.8 DETAILED CLIMATOLOGY ANALYSIS OF INDOCHINA

The climatology data for Indochina discussed in Sections 2.4 through 2.7 describe the weather in terms of political boundaries. In order to use these data for systematic analysis of operations, it is desirable to present the climatology data in terms of climatic areas. Consequently, Indochina has been divided into five distinctive climatic areas and a detailed analysis has been completed for each area. The five different climatic areas are shown in Figure 2-4.

The data presented in Section 2.8 represent an average day for the months of January, April, July, and October. These months were selected because they are typical, respectively, of the two seasons and the transitions between the seasons. The monthly average values of illumination, cloud cover, surface temperature, visibility, and surface wind speed are summarized in Figures 2-12 through 2-36.

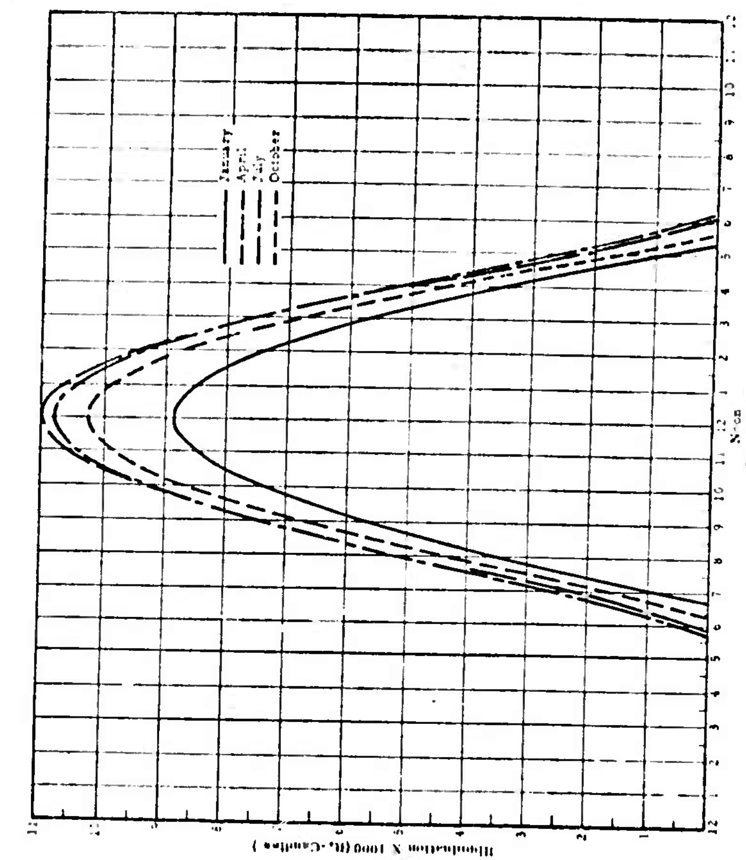


Figure 2-12 Illumination (Clear Sky) Area No. 1

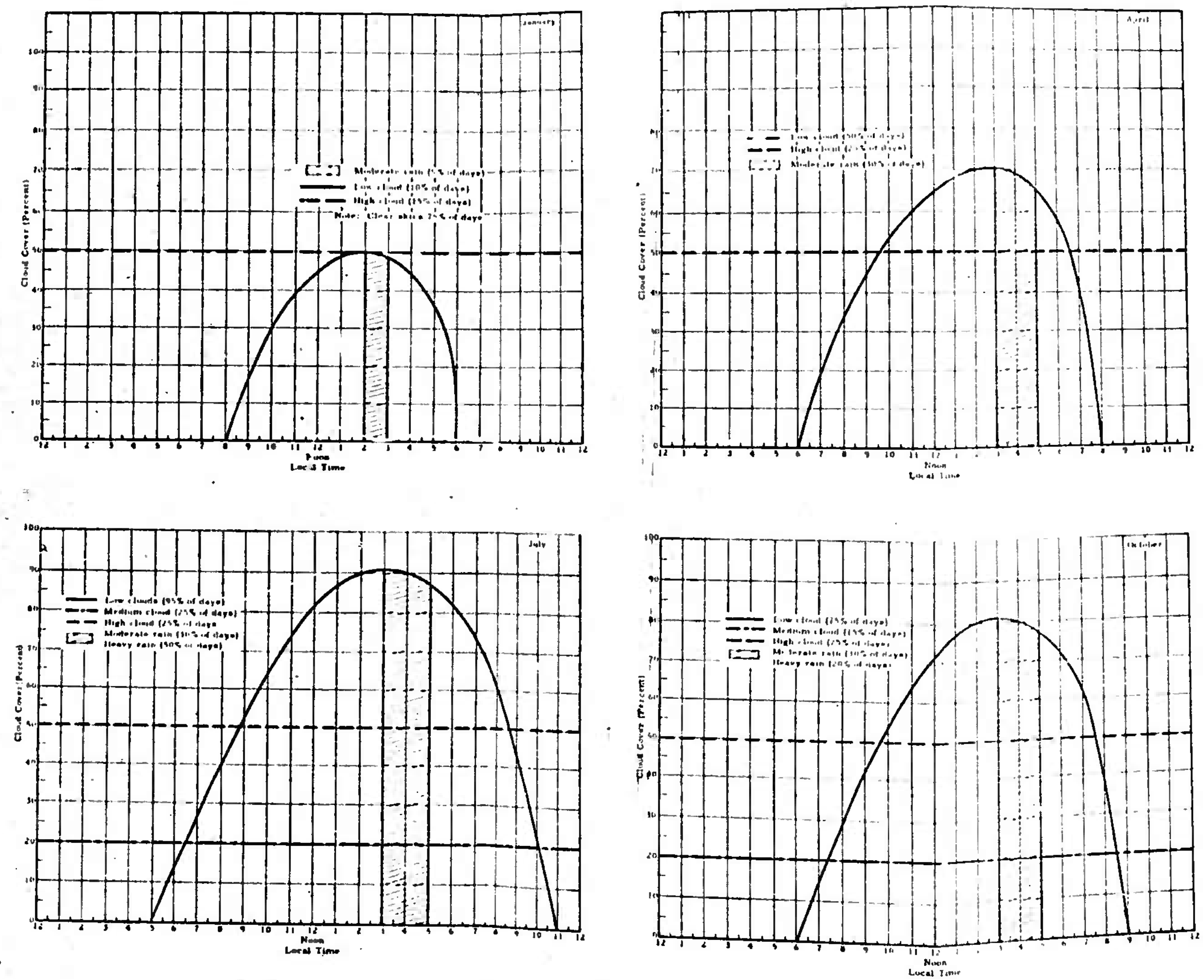


Figure 2-13 Daily Average Cloud Cover (Area No. 1) for January, April, July, and October

B.2-63/B.2-64

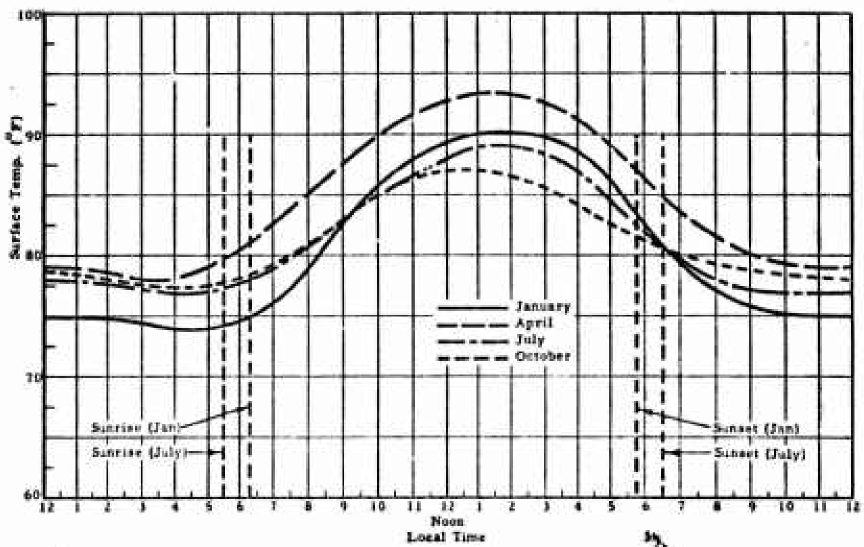


Figure 2-14 Daily Average Surface Temperature (Area No. 1)—January April, July, and October

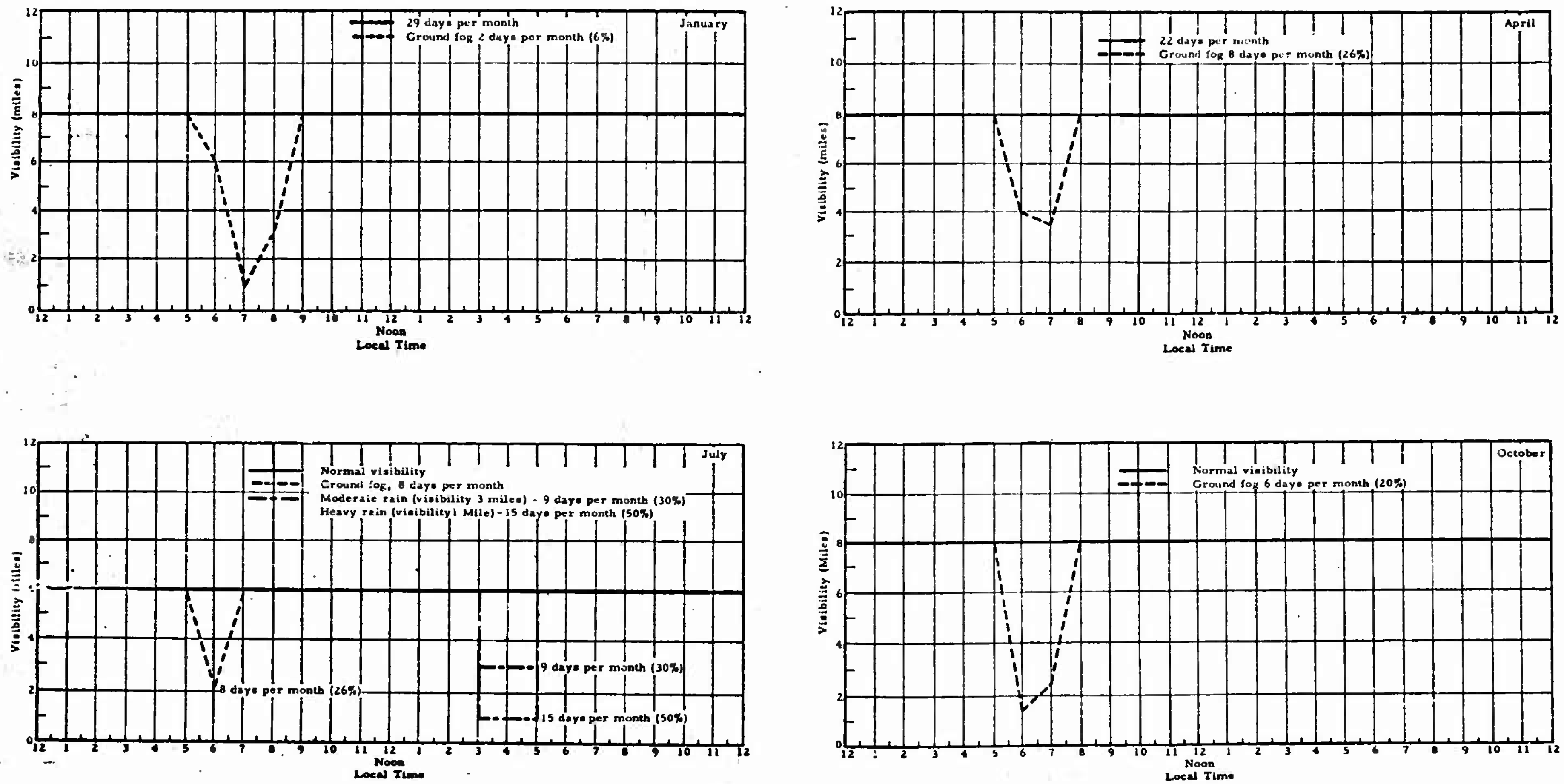


Figure 2-15 Daily Average Visibility (Area No. 1) — January, April, July, and October

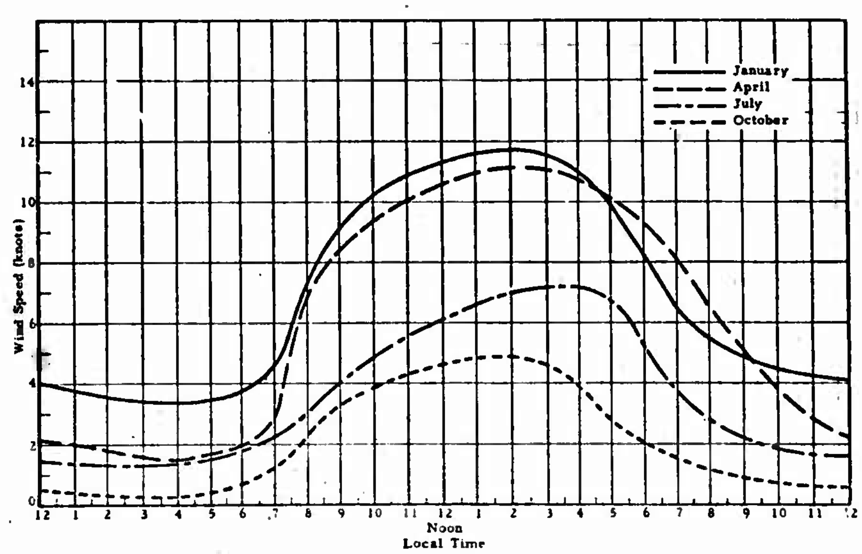


Figure 2-16 Daily Average Wind Speed (Area No. 1) - January, April, July, and October

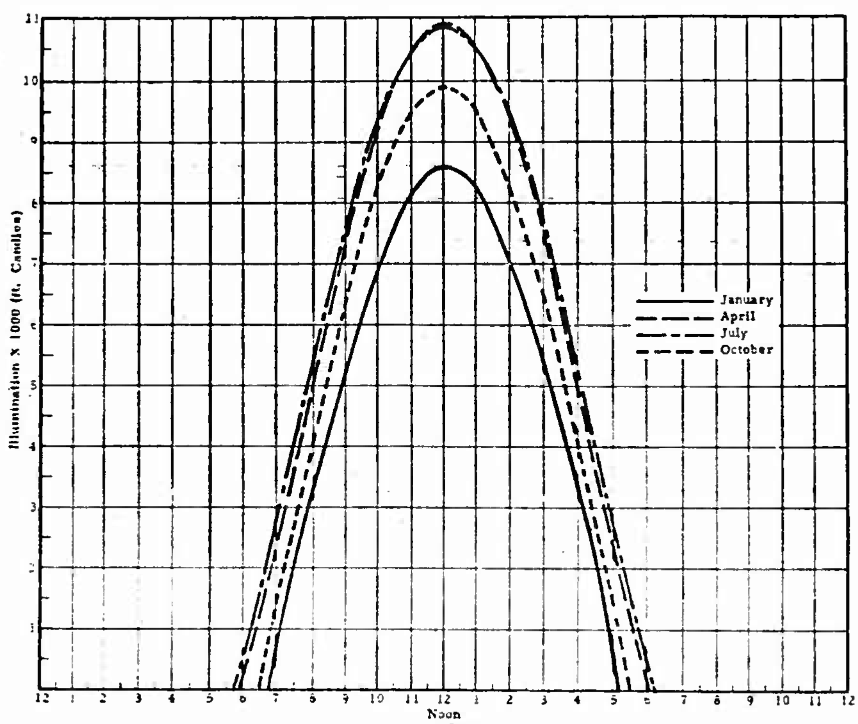


Figure 2-17 Illumination (Clear Sky) Area No. 2

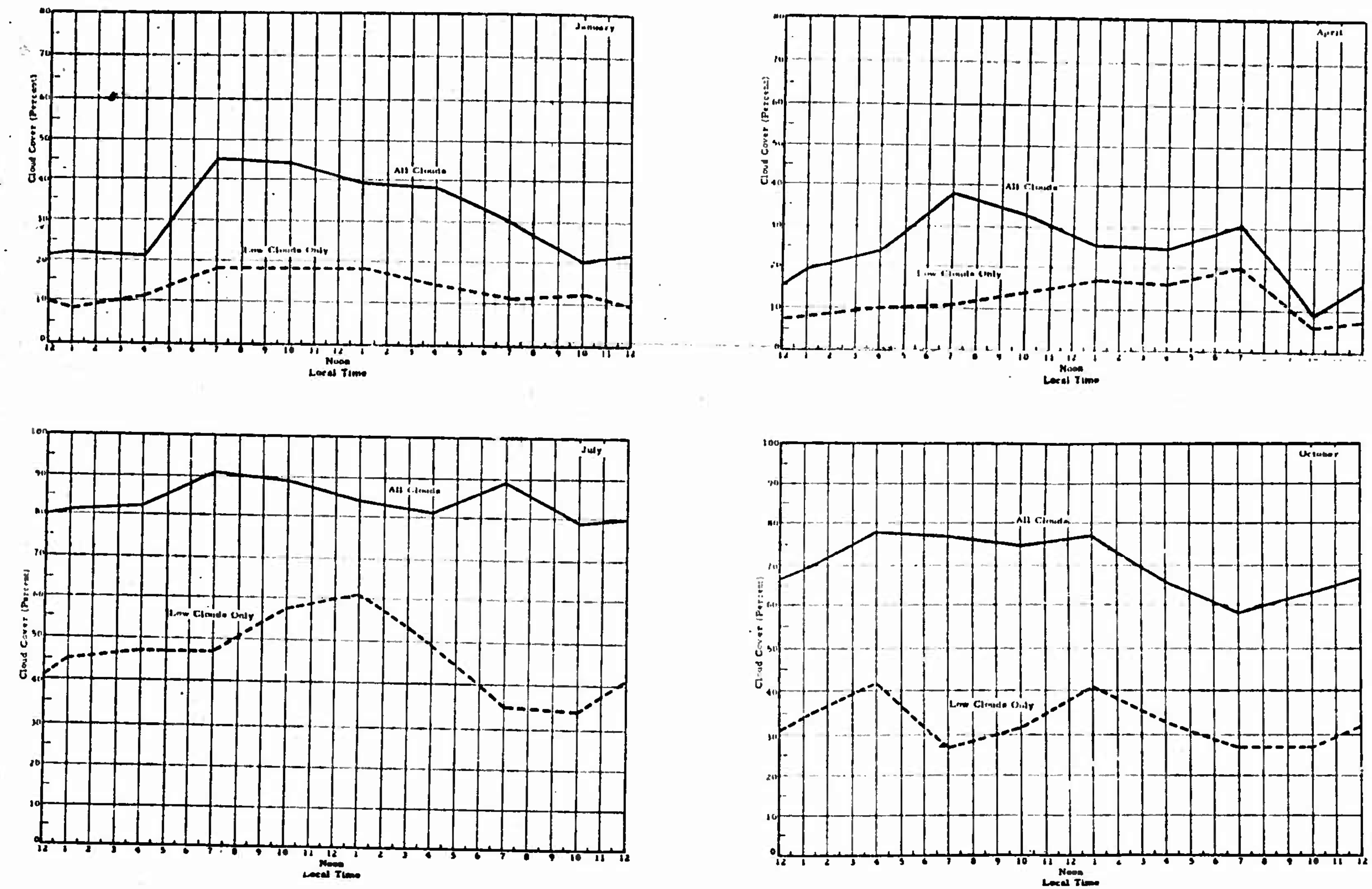


Figure 2-18 Daily Average Cloud Cover (Area No. 2) for January, April, July, and October

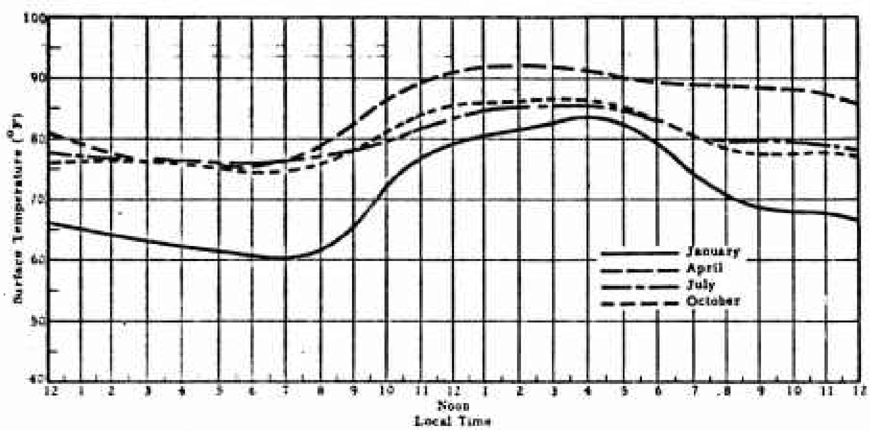


Figure 2-19 Daily Average Surface Temperature (Area No. 2) for January, April, July, and October

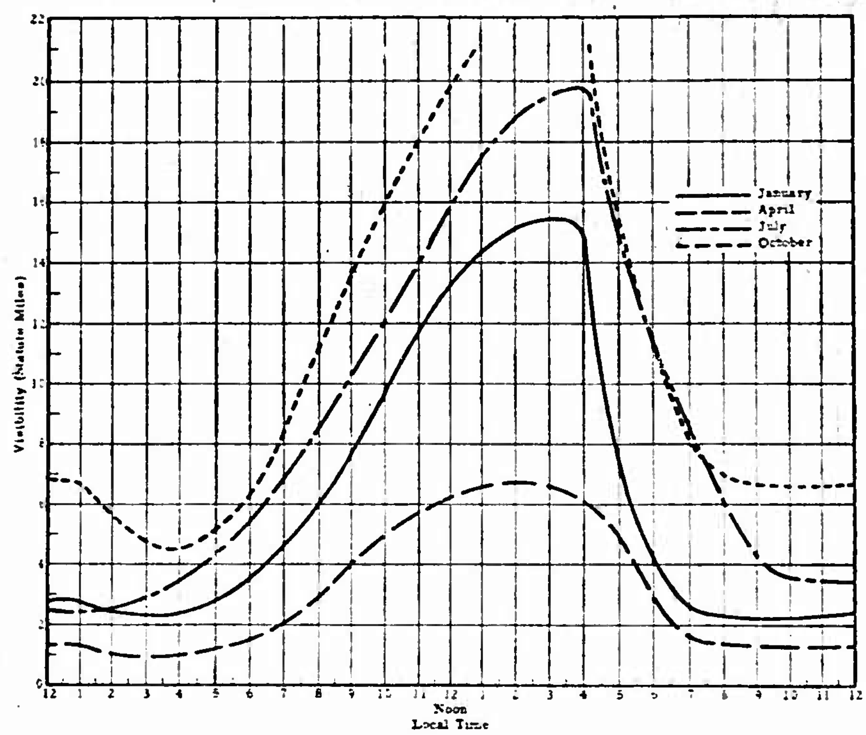


Figure 2-20 Daily Average Visibility (Area No. 2) for January, April, July, and October

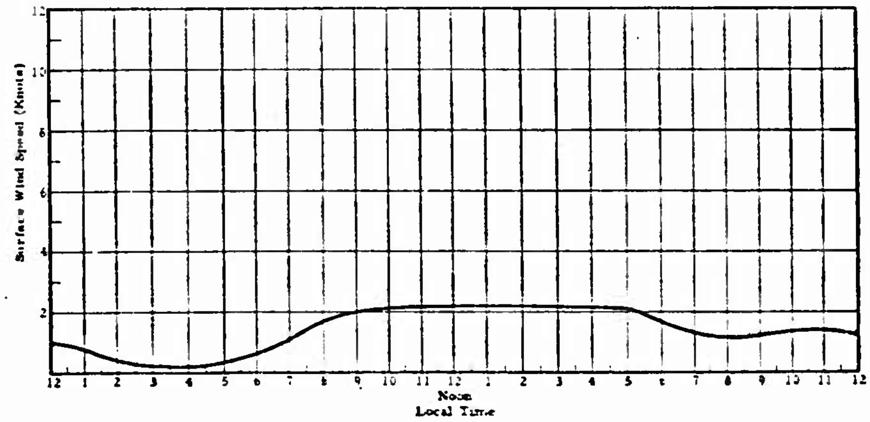


Figure 2-21 Daily Average Surface Wind Speed (Area No. 2) for January, April, July, and October

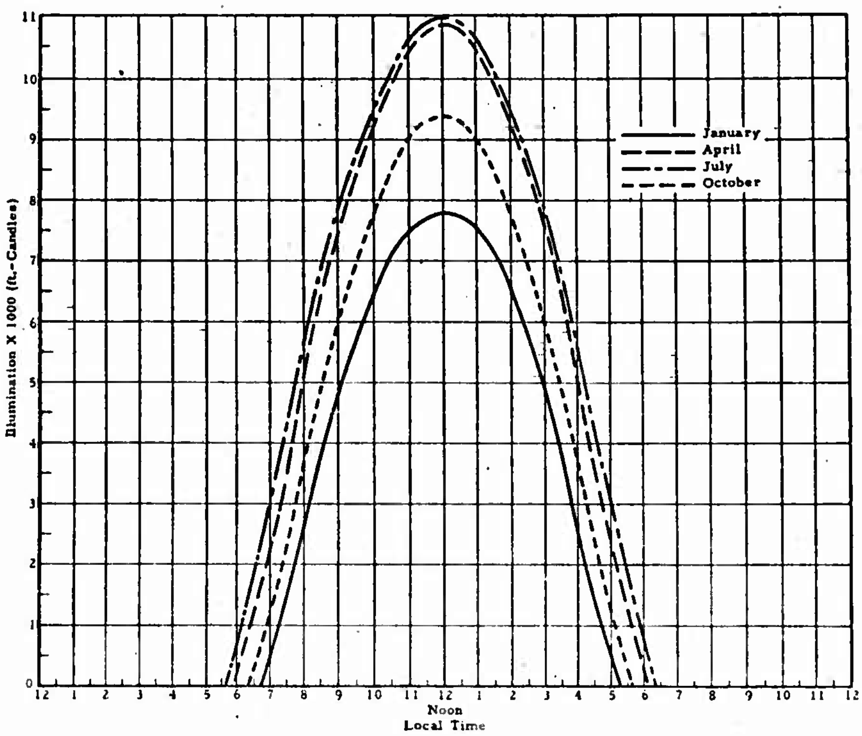


Figure 2-22 Illumination (Clear Sky) Area No. 3

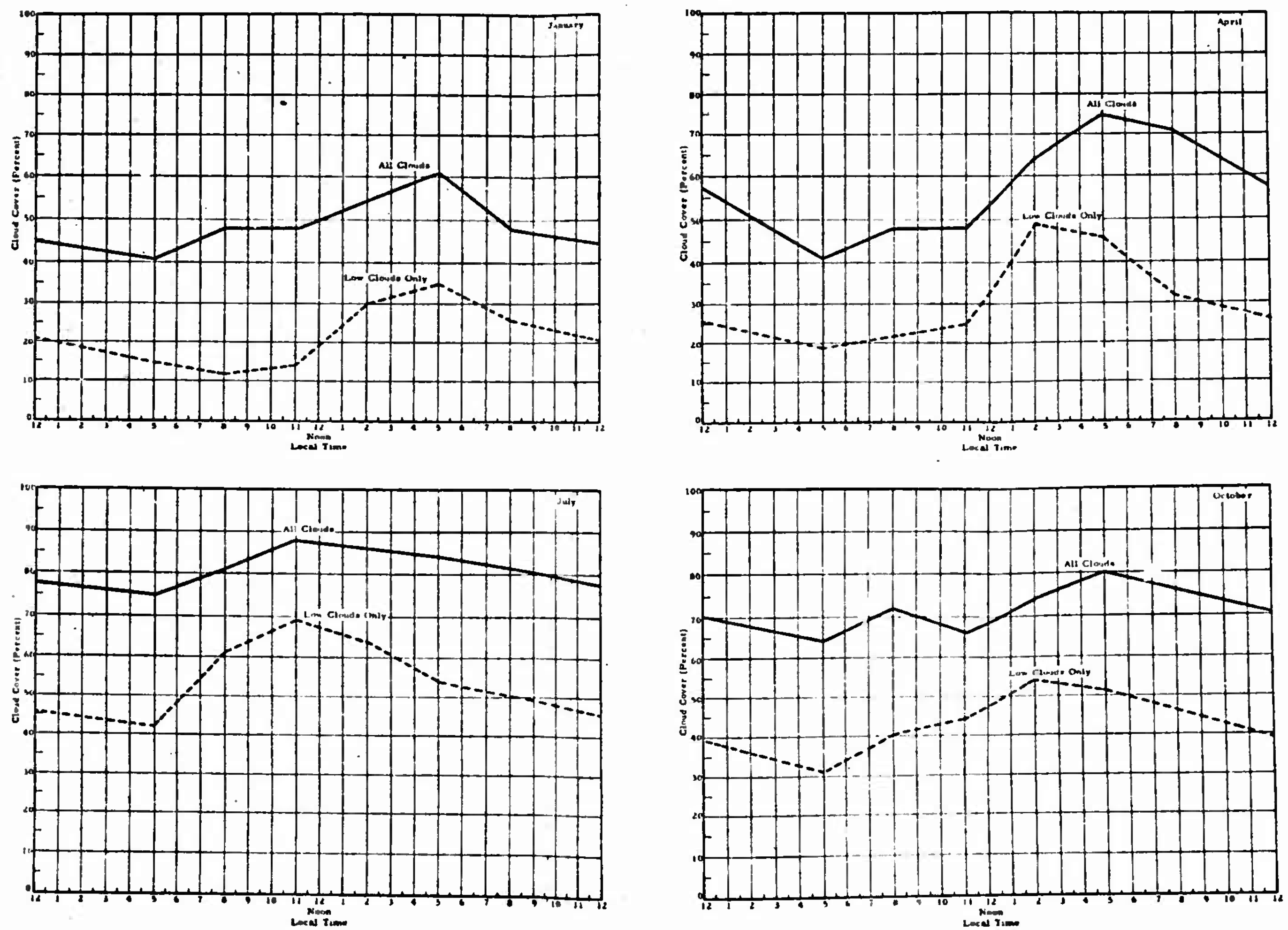


Figure 2-23 Daily Average Cloud Cover (Area No. 3) for January, April, July, and October

B.2-77/B.2-78

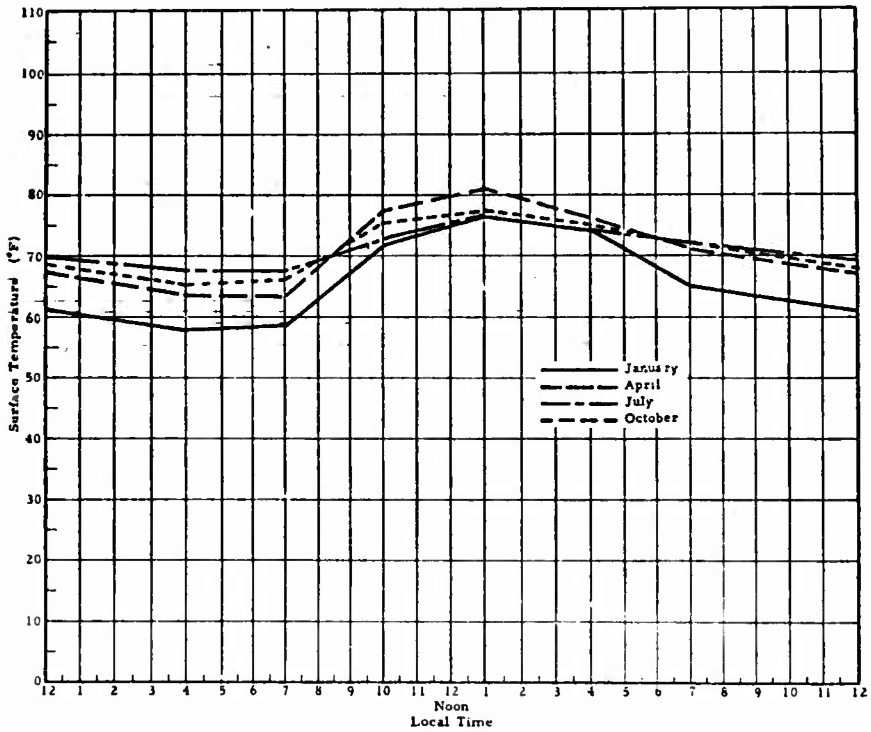


Figure 2-24 Daily Average Surface Temperature (Area No. 3) for January, April, July, and October

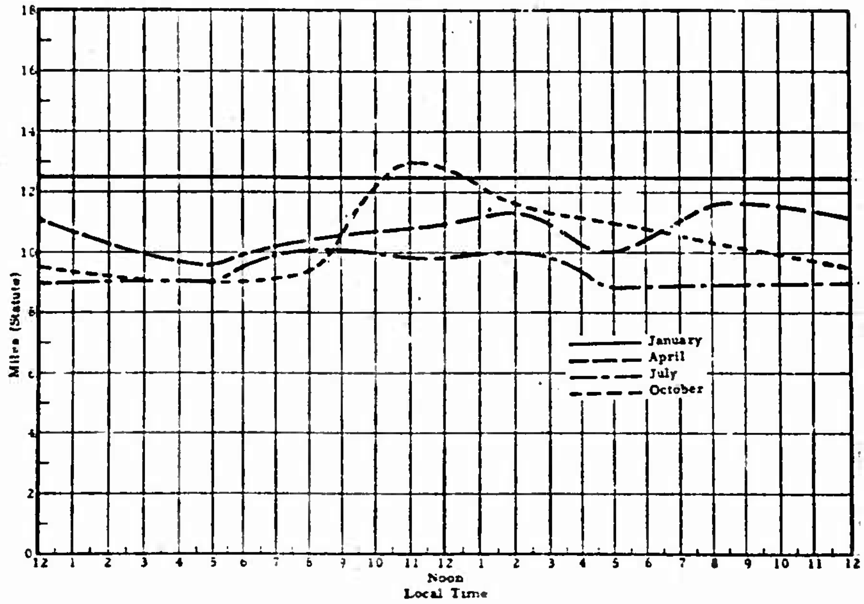


Figure 2-25 Daily Average Surface Visibility (Area No. 3) for January April, July and October

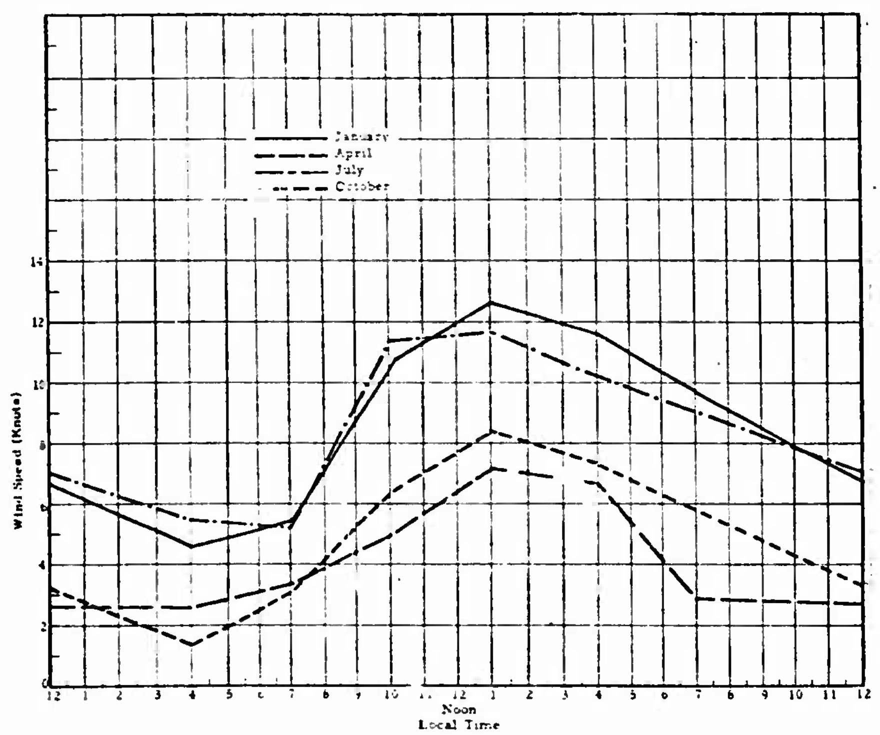


Figure 2-26 Daily Average Surface Wind Speed (Area No. 3) for January, April, July, and October

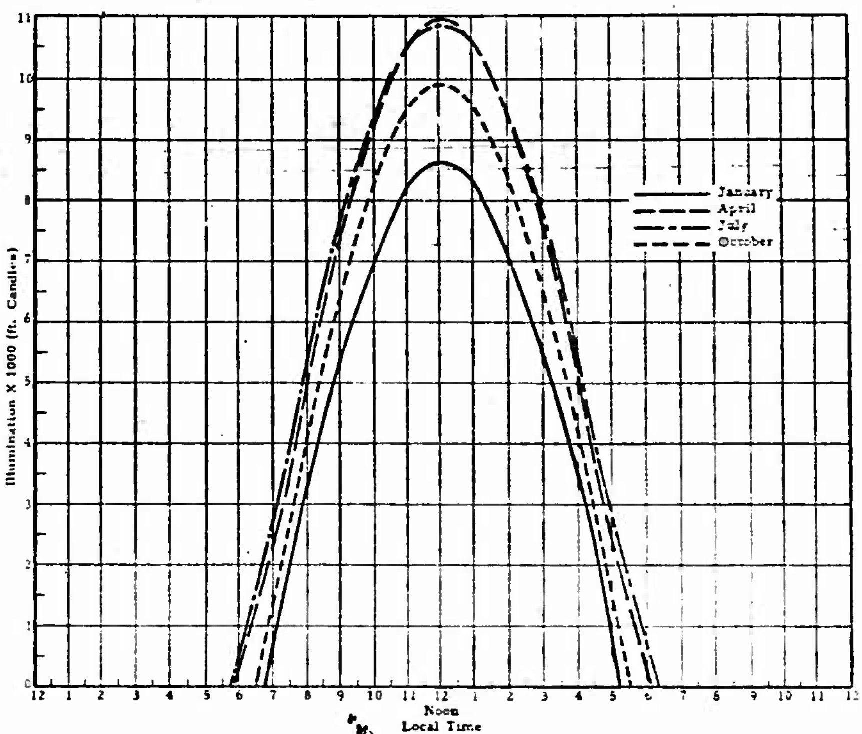


Figure 2-27 Illumination (Clear Sky) Area No. 4

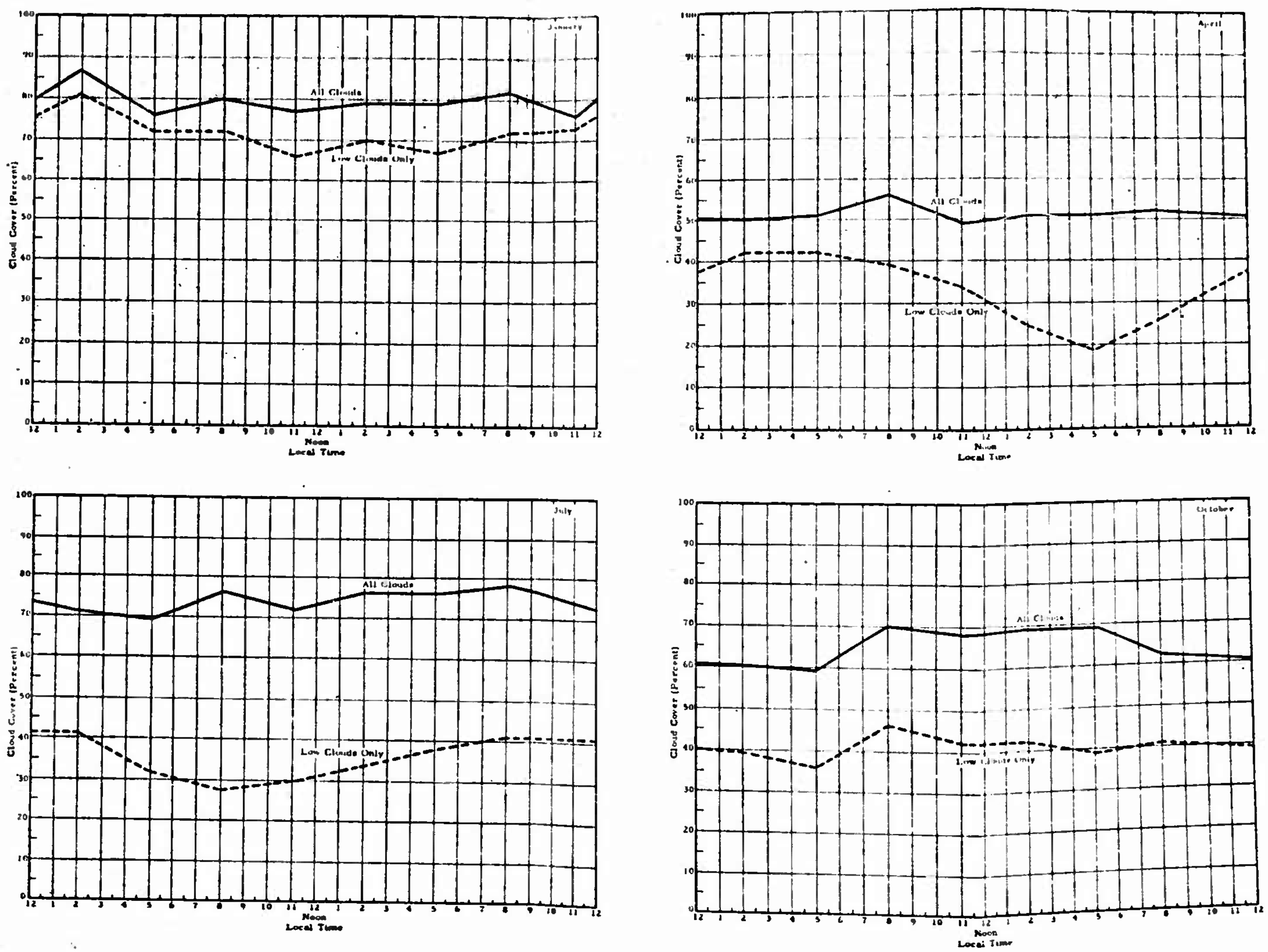


Figure 2-28 Daily Average Cloud Cover (Area No. 4) for January, April, July, and October

B. 2-83/B. 2-84

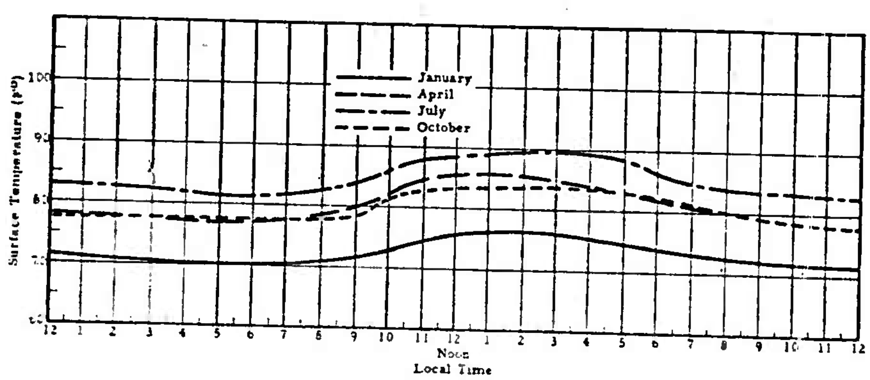


Figure 2-29 Daily Average Surface Temperature (Area No. 4) for January, April, July, and October

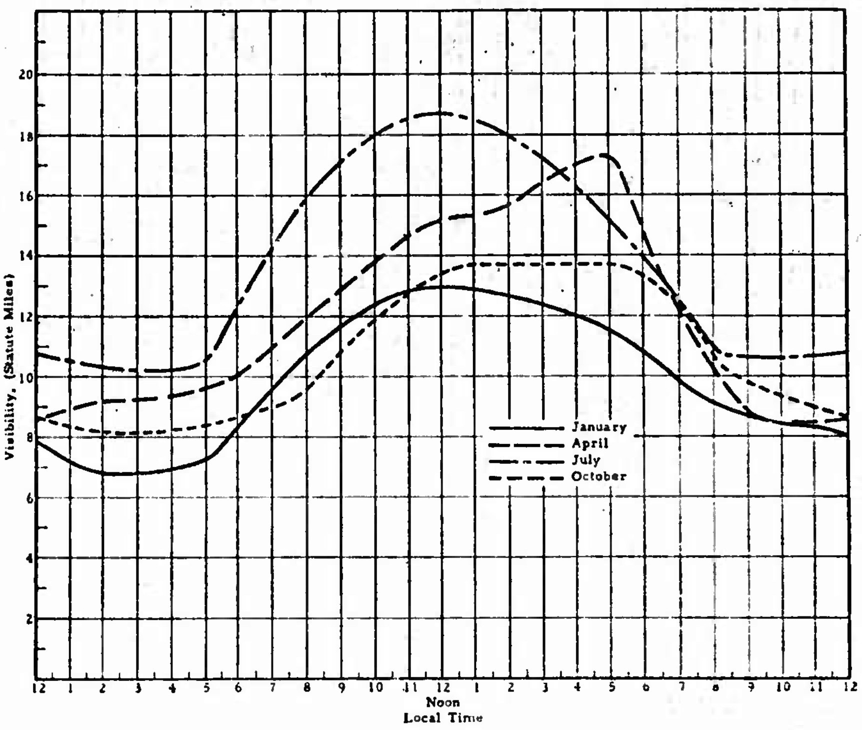


Figure 2-30 Daily Average Visibility (Area No. 4) for January, April, July, and October

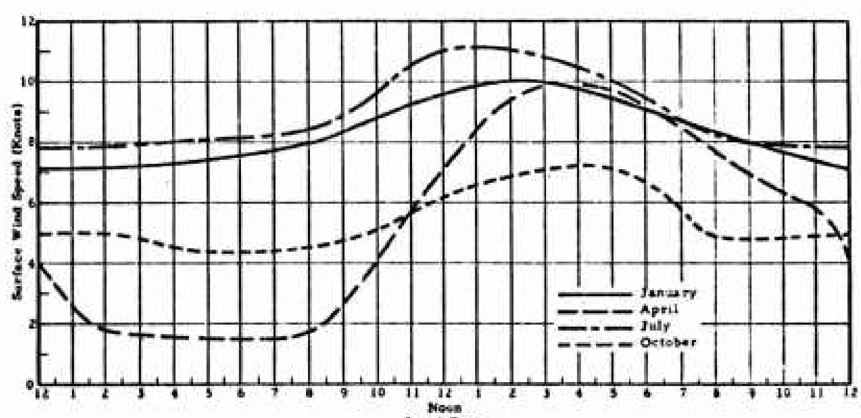


Figure 2-31 Daily Average Surface Wind Speed (Area No. 4) for January, April, July, and October

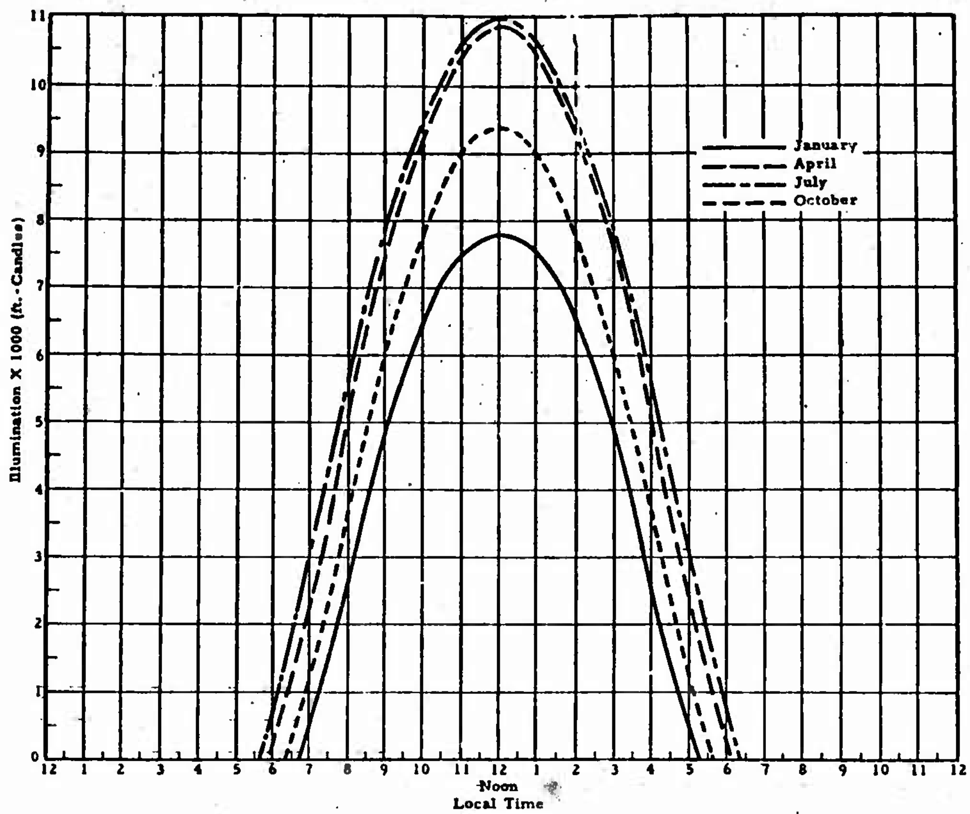


Figure 2-32 Illumination(Clear Sky) Area No. 5

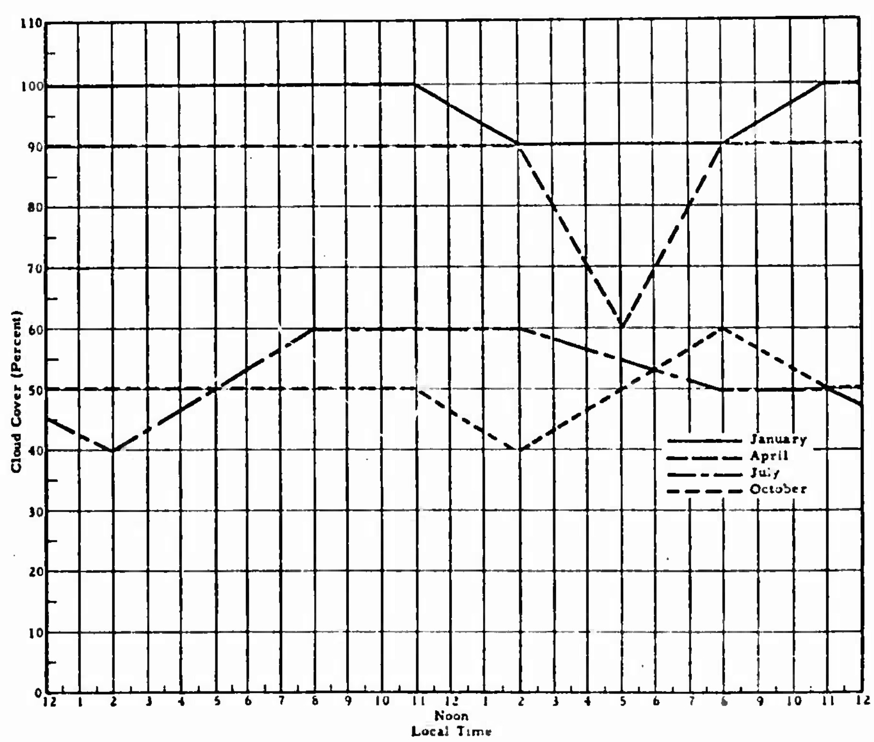


Figure 2-33 Daily Average Cumulus Cloud Cover (Area No. 5) for January, April, July, and October

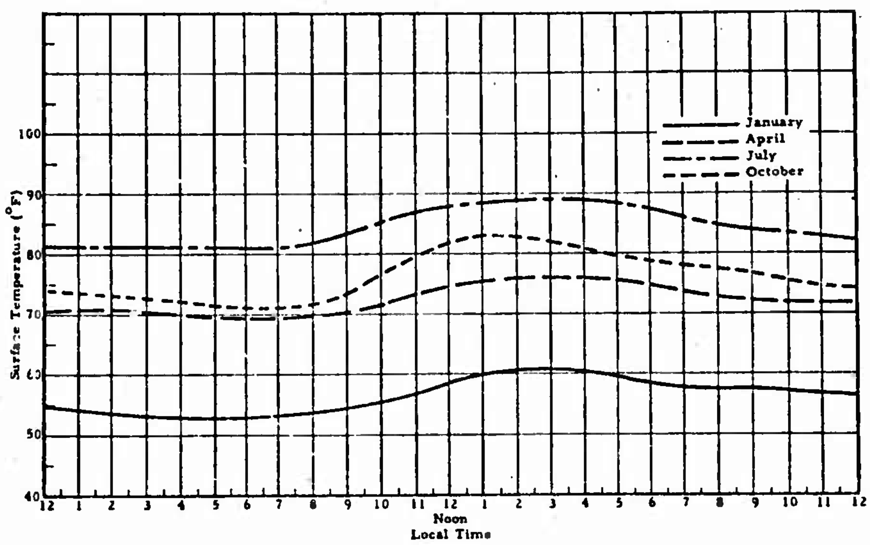


Figure 2-34 Daily Average Surface Temperature (Area No. 5) for January, April, July, and October

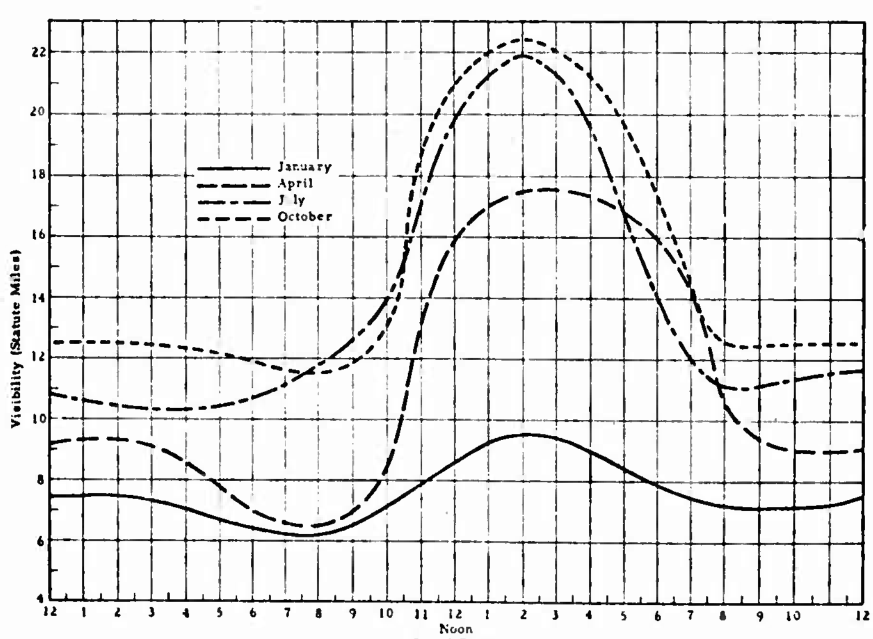


Figure 2-35 Daily Average Visibility (Area No. 5) for January, April, July, and October

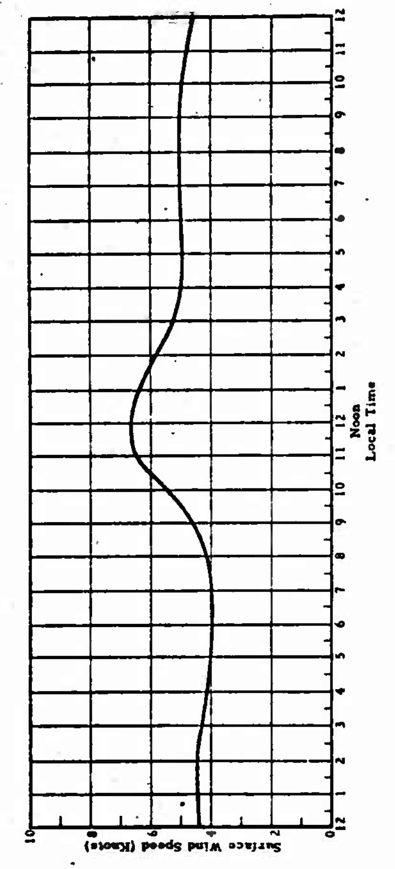


Figure 2-36 Daily Average Surface Wind Speed (Area No. 5) for January, April, July, and October

SECTION 3

TOPOGRAPHY AND CLIMATE OF CENTRAL EUROPE

3. 1 TOPOGRAPHY

3. 1. 1 Mountain Ranges

The mountain ranges of Central Europe are shown in Figure 3-1. The Harz Mountains in central Germany are an isolated mass reaching 3740 ft, the highest point in the German interior. South of the Harz Range and parallel to it, running northwest to southeast, is the Thuringian Range, attaining a height of 3240 ft, with deeply eroded valleys on the slopes. Continuing to the southeast are the mountain systems of the Frankenwald, Fichtelgebirge, and Bohmerwald. Trending northeast from the mountain knot of the Fichtelgebirge are the Erzebirge or Ore Mountains which rise on the German-Czechoslovakian frontier and attain maximum elevations in excess of 3980 ft. A center grouping of volcanic masses includes the Vogelsberg and Hohe Rhom or Rhoen Mountains, separated by the Fulda Valley, and reaching to 2540 ft and 3120 ft, respectively.

The Spessart, a mass of rolling nills culminating at an altitude of 2030 ft, lies south of the Vogelsberg Mountains. Conspicuous in the southwest is the broad upper Rhine Plain, extending from north of the Swiss border to Mainz and averaging 23 miles in width. In the southwest corner is the rugged, picturesque Schwarzwald, attaining an elevation of 4920 ft. To the north and east of the Rhine is the Odenwald with an elevation of over 2000 ft. Across the Rhine from Odenwald is the Hardt, an upland area reaching 2240 ft. Extending across southern Germany just north of the Danube are the low, irregular ridges of the Swabian Jura and the Franconian Jura, separated by the Reis Basin northwest of Donauworth and elevated about 1000 ft above the plateau.

The Alps are represented in Germany by a narrow strip of the outer limestone zone containing the Zugspitze (6730 ft), the highest point in Germany. Although only a minor part of the great Alpine system, it forms a serious barrier to trans-Alpine communications.

3.1.2 Terrain Patterns

Germany's major terrain and vegetation patterns include a number of diverse physiological regions.

North Coast and Islands

The German coasts are shallow and silted. Owing to tidal conditions, even the Elbe River has difficulty in scouring its estuary. The rocky island of Heligoland holds a strategic position off the North Sea coast opposite the mouths of the Weser and Elbe Rivers and the Kiel Canel.

North German Plain

This is part of the great Eurasiatic Plain. The western section, about 120 miles wide, is drained to the North Sea by the Weser, Ems, and Elbe Rivers.

The Borde

Extending along the zone of contact between the Northern Plain and the Central Highlands is a narrow transitional belt known as the Borde. This deposits on the valley slopes and terraces, and on the flattened summits of the Flaming and Lusatian Ridges.

The Central Highlands

This region, the Mittle-Gebirge or Hercynian Mountains comprising the greater part of Western Germany, lies between the North German Plain and the Borde on the North and the Alps on the south, increasing in height and decreasing in breadth from west to east.

3.2 CLIMATE

The climate of Germany is primarily maritime in nature, but it is modified at times by drier continental influences. Generally, it is characterized by year-round cloudy skies and frequent precipitation. Although precipitation is frequent, the total amount during any month is usually relatively small. The main seasonal differences in the climate are the type of clouds and precipitation plus the changes in temperature. The climate is discussed under the categories of the four common seasons: winter, spring, summer, and fall.

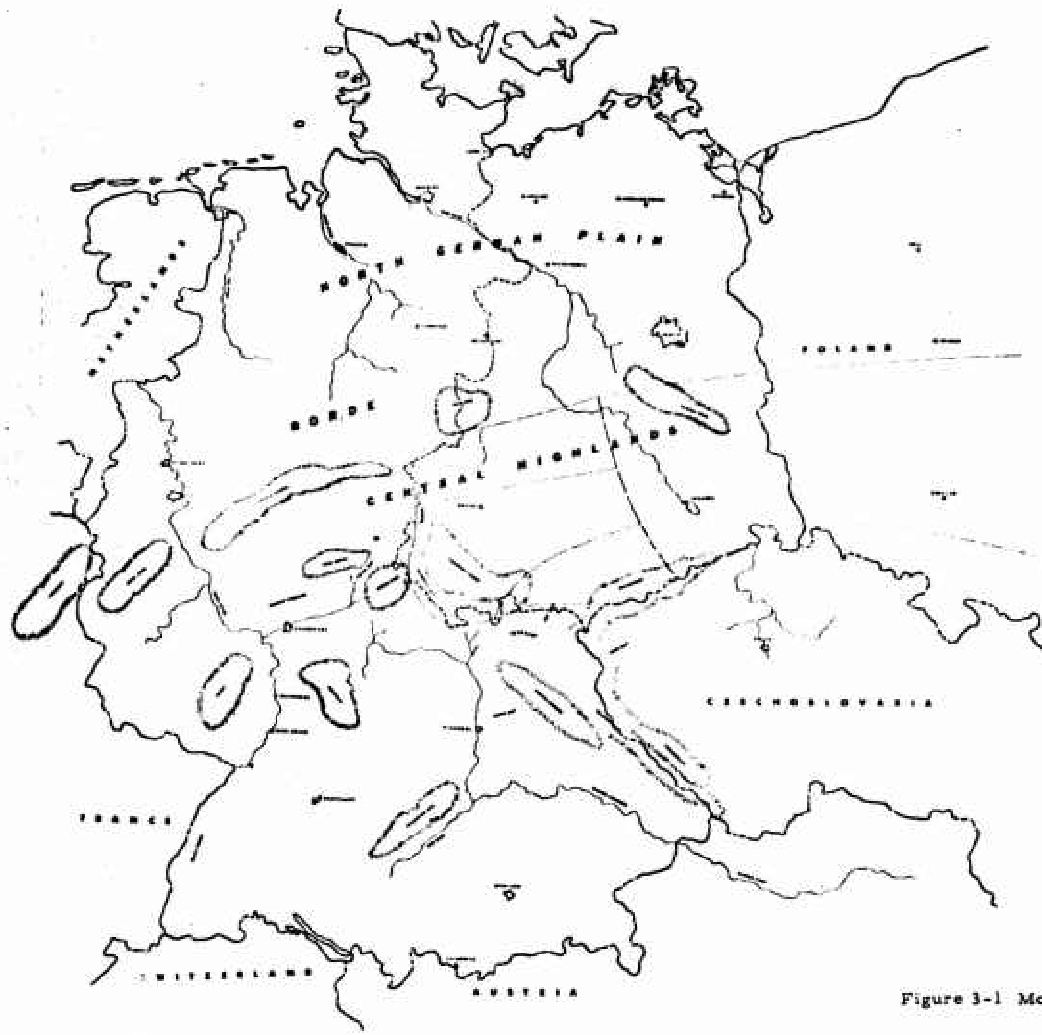


Figure 3-1 Mountain Ranges of Germany

Winter

December through February is characterized by stormy, cool, wet and cloudy weather which is broken occasionally by intermittent periods of very cold, dry and windy conditions. Alternating migratory low pressure and high pressure areas result in a predominantly westerly wind flow from the North Atlantic Ocean, which is the major influence upon the climate. Temperatures are much higher than would be expected at these northerly latitudes (West Germany lies at a latitude equivalent to that of Newfoundland and Southern Labrador) because of the influence of the relatively warm water that parallels the western coast of Europe. Mean daily maximum temperatures in the high 30s decrease to the high 20s at night. Rivers and smaller lakes are usually frozen for lengthy periods. Although the temperatures are not extremely low, the prevailing high humidity, coupled with occasionally strong surface winds, causes a much higher discomfort index to personnel than would normally be experienced. Effects of the ocean also cause extensive stratus type clouds with bases often below 2000 ft. Most locations average 20 to 25 days per month with cloud cover equal to or greater than 75%. Ceilings below 2000 ft occur 40 to 60% of the time. Precipitation, although usually of light intensity, may last for days or weeks at a time, occurring on an average of more than half the days during the season. Because temperatures are often close to the freezing point, rain mixed with snow, freezing rain, or heavy wet snow often occur. Snow is frequent and cover of varying depth exists about 40 to 60 days at elevations of 1000 ft, and for longer periods at higher elevations. Smoke around the industrial areas is often trapped in the air near the surface, restricting visibility to three to five miles 60 to 80% of the time. Fog, primarily of the radiation type, is frequent and occurs mostly during early morning hours. Occasionally, the moist westerly wind flow is interrupted by a very cold, dry, easterly wind from the central Asiatic high. When this occurs, clear skies, gusty surface winds and below zero temperatures may last for days. If there is a sudden intrusion of relatively warm, moist air which overrides the cold air mass, extensive fog, low ceilings and snow are almost sure to occur and may persist for three to four days at a time. Surface winds are predominantly westerly, however, many deviations are created by the rugged terrain. Maximum wind velocities of greater than 28 knots occur on an average of only one day per month, except for the higher exposed elevations. Zugspitze, the highest point in West Germany, has winds greater than 28 knots on an average of 12 to 15 days per month.

Spring

The transition from winter to summer (March through May) is usually gradual and the date of beginning may vary by a month or so. Temperatures gradually increase as the season progresses and, by May, mean daily maximum temperatures are in the 60s (°F). Daily minima are in the high 40s and only the higher elevations report below-freezing temperatures. Snow cover at the lower elevations is usually completely gone by early April. As the land begins to warm and the cold Asiatic High begins to diminish in intensity, more frequent intrusion of maritime air from the Atlantic occur. Moist air flow predominates and extensive cloudiness still prevails; however, the increase in solar heating over the land causes the low cloud type to gradually change from a prevailing overcast cloud layer of stratus and stratocumulus to a predominantly broken cloud layer of cumulus and cumulonimbus. There is an increase in middle and high clouds. The amount of low clouds and frequency of low ceilings drastically decreases from the winter maxima. Precipitation still occurs on more than half the days. A gradual increase in the amount of rainfall reflects the change from the light, continuous type in winter to the shorter, but heavier, shower type. Thunderstorm activity (almost completely absent in winter) increases sharply as the season progresses. Humidity, although still relatively high, usually has the lowest value of the year. This is a reflection of lower cloud amount, long days with accompanying convective activity and a reasonable amount of atmospheric motion. Visibilities improve rapidly as fog and low stratus clouds show a distinct decrease in frequency of occurrence. Surface winds are predominantly westerly and northwesterly. Gusty surface winds, associated mostly with frontal systems, often occur, but with decreasing frequency, as the season progresses and, by May, winds are mostly light and variable. Warm, dry winds called "Foehns" occur along the northern slopes of the Alps. These winds sometimes reach gale force and have been known to dissipate as much as a foot of snow a day.

Summer

From June through August, air from the Atlantic Ocean still predominates. Since the effects of the relatively cool ocean prevail, summers are usually mild with mean daily maximum teperatures in the 70s, decreasing to the 50s at night. Extreme temperatures of over 80°F, associated with hot, dry easterly winds from the western Asiatic Low, interrupt the prevailing westerly flow on an average of two to three times a month. Maritime air passing over the heated land produces much cumulus and cumulonimbus type clouds, showers and thunderstorms. Thunderstorms increase in frequency and intensity over those of the spring months. Because of the convective activity, a decided diurnal effect prevails, with maximum cloudiness and precipitation during afternoon hours. Bases of clouds are mostly at about 2000 ft. Fog is rare. Visibilities are usually excellent, except during rainfall. Severe thunderstorms, accompanied by torrential rain, gusty surface winds and hail occur occasionally, but are local phenomena and of relatively short duration. Surface winds are predominantly northwesterly. Calm and very light winds are frequent during night and early morning. Strong, gusty surface winds (over 25 knots), mostly associated with thunderstorms, occur on an average of one to three days per month.

Fall

September through November is a time of progressive change from the showery conditions of summer toward the dull, cloudy and rather foggy winters. Temperatures begin to decrease rapidly in October. Freezing temperatures occur by October and are common in November. September is usually quite similar to summer, but by October strong frontal activity begins once again to affect the area. Cloud types begin to change from the cumulus in summer toward the prevailing low stratus of winter and a decided increase in mean cloudiness is experienced, especially in November. Precipitation still occurs on about half the days, but a general decrease in amount indicates that the relatively short, heavy shower activity is being replaced by the light, continuous type. By November, thunderstorm activity has ceased almost entirely. The first snowfall usually occurs in early November. Visibilities are usually excellent in September, but frequency of restrictions to visibility due to fog and low stratus clouds increases sharply in October and November. November is one of the foggiest months of the year. The prevailing light wind and rapid cooling at night produce much radiational fog. However, compared to winter conditions when extensive fog may persist for extended periods of time, fog in November is usually localized and seldom persists more than two hours after sunrise. Surface winds are predominantly westerly. Frequency of strong, gusty surface winds increases as the season progresses.

3.3 SPECIAL WEATHER PHENOMENA

Tornadoes have been reported, but are a rare occurrence and cause little damage. Violent thunderstorms are cloudbursts occur occasionally

during the summer but are local phenomena causing little damage. During the early spring, rivers occasionally flood the surrounding lowlands. This occurs when a rapid melting of snow in the highlands and ice in the rivers and frequent rainfall combine to produce an unusually large runoff.

3.4 DURATION OF DAY (SUNRISE TO SUNSET)

Duration of day is a function of latitude and time of year (elevation of an observer is considered at a constant sea level). The area of concern for this study is located between approximately 48° and 51° N latitudes. Extreme values for duration of daylight during the year are:

June 22 (Longest day of year):

@ 51°N - 16 hrs 16 min

@ 48°N - 16 hrs 04 min

December 21 (Shortest day of year):

@ 51°N - 7 hrs 55 min

@ 48°N - 8 hrs 22 min

Time of sunrise and sunset can be approximated by dividing the duration of the daylight by two and subtracting it from, or adding it to, time of local noon. Local Standard Time (LST) for West Germany is equal to Greenwich Meridian Time (GMT) plus one hour. Duration of civil twilight varies during the year. At the beginning of spring and fall, civil twilight begins approximately 33 minutes after sunset; at the beginning of winter add six minutes to the time above (39 minutes) and for the beginning of summer add another six minutes (45 minutes). For exact values of sunrise and sunset, plus data on moonset and moonrise, consult a current astronomical almanac.

3.5 DETAILED CLIMATOLOGY ANALYSIS OF CENTRAL EUROPE

The climatology analysis presented in this section was taken from synoptic meteorology data reported by seven weather stations in Central Europe as supplied by the Air Weather Service. In addition, climatic summary data are presented in Tables 3-1 to 3-6 for six stations in Germany. Both the stations used for the cloud cover and visibility analysis and the climatic data summary are shown on themap in Figure 3-2.

TABLE 3-1

CLIMATIC DATA SUMMARY (MANHEIM)

CLIMATIC DATA SUMMARY							Station: Manheim, Germany					
Field Location 49° 30'N 08° 35'E	Field Elevation 360 Feet			YEARS of Record 10 to 50 Years					Date Apr 64			
Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
TEMPERATURE												
Extreme Maximum	60	66	76	82	91	93	101	100	91	79	69	64
Mean Daily Maximum	38	42	49	[illegible]	67	72	75	74	67	56	45	39
Mean Daily Minimum	29	31	35	41	49	54	58	57	51	44	36	31
Extreme Minimum	-8	-9	9	22	30	38	44	44	35	22	9	3
Humidity Mean Monthly %	86	82	75	68	68	67	69	71	78	83	67	87
PRECIPITATION												
Mean Monthly Precipitation (inches) Snowfall (inches)	1.1	1.0	1.2	1.5	1.8	2.4	2.6	2.4	2.2	1.8	[illegible]	1.3
Mean No. of Days												
Precipitation	14	13	14	14	14	14	14	14	13	13	13	15
Measurable Snowfall	5	4	3	1	**	0	0	0	0	**	2	4
Thunderstorms	0	**	1	1	4	6	5	4	1	**	**	0
Haze or Fog												
FLYING WEATHER (PERCENTAGE)												
Observations with ceilings < 5000 ft A/O visibility < 5 Miles												
Observations with ceilings < 1500 ft A/O visibility < 3 Miles												
Observations with ceilings < 1000 ft A/O visibility < 1 Mile	18	16	7	2	1	3	1	2	5	18	18	23
Observations below 500 ft A/O 1 Mile	16	14	6	1	1	2	1	1	4	17	17	20
TAKE OFF DATA												
Mean Vapor Press (in. hg)												
Temperature of Dew Pt.												
99.25% Press. Alt (Feet)												
REMARKS:												
DAYS WITH:												
Snowcover ≥ Trace	8	7	2	**	0	0	0	0	0	0	**	2

NOTE: *Data not available **Less than 0.6 days, 06% or .06 in. as applicable.

TABLE 3-2

CLIMATIC DATA SUMMARY (NUERNBERG)

CLIMATIC DATA SUMMARY						Station: Nuernberg, Germany						
Field Location: 49°30'N 11°05'E	Field Elevation: 1,045 Feet		YEARS of Record: 5 to 40 years							Date: Apr 64		
Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
TEMPERATURE												
Extreme Maximum	58	67	73	81	92	92	100	99	93	82	70	64
Mean Daily Maximum	35	39	47	56	66	71	74	72	66	55	44	37
Mean Daily Minimum	26	27	32	38	46	52	55	54	48	41	34	29
Extreme Minimum	-18	-22	2	13	26	32	40	31	27	18	4	-17
Humidity Mean Monthly %	80	72	62	54	53	54	55	57	62	70	77	82
PRECIPITATION												
Mean Monthly Precipitation (inches) Snowfall (inches)	1.5	1.2	1.3	1.7	2.2	2.5	3.1	3.2	2.1	2.1	1.9	1.7
Mean No. of Days Precipitation	16	14	14	15	15	15	15	15	13	13	14	17
Measurable Snowfall	9	7	6	3	*	0	0	0	0	1	4	8
Thunderstorms	#	0	#	1	7	10	9	7	2	*	*	0
Haze or Fog												
FLYING WEATHER (PERCENTAGE)												
Observations with Ceilings <5000 ft A/O Visibility <3 Miles												
Observations with Ceilings <1500 ft A/O Visibility <3 Miles												
Observations with Ceilings <1000 ft A/O Visibility <3 Miles	37	43	20	12	8	6	12	13	21	41	46	44
Observations Below 500 ft A/O 1 Mile	8	13	4	3	2	2	3	4	7	16	14	12
TAKE OFF DATA												
Mean Vapor Pressure												
Temperature of Dewpt.												
99.95% Pres. Alt. (ft)												

REMARKS:

DAYS WITH:

Snowcover ≥ Trace Not available

NOTE: * Data not available. # Less than 0.6 days, 0.6% or .06 in., as applicable

TABLE 3-3

CLIMATIC DATA SUMMARY (RHEIN/MAIN)

CLIMATIC DATA SUMMARY						Station: Frankfurt (Rhein/Main), Germany						
Field Location 50° 02'N 08° 34'E	Field Elevation: 368 Feet		YEARS of Record 10 Years							Date Apr 64		
Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
TEMPERATURE												
Extreme Maximum	57	65	73	85	89	93	101	93	93	75	63	61
Mean Daily Maximum	37	40	52	59	67	72	75	74	68	57	45	40
Mean Daily Minimum	28	28	34	39	45	52	56	54	50	43	36	32
Extreme Minimum	-1	-5	8	20	26	34	38	38	32	24	10	4
Humidity Mean Monthly %	86	83	75	70	69	71	72	75	79	85	87	88
PRECIPITATION												
Mean Monthly Precipitation (inches) Snowfall (inches)	1.8	1.4	1.2	1.6	2.3	3.4	2.9	3.0	2.2	2.4	2.0	2.3
Mean No. of Days Precipitation	22	19	15	18	17	18	18	19	16	18	19	22
Measurable Snowfall	12	10	4	2	#	0	0	0	0	0	2	7
Thunderstorms	#	#	1	1	4	5	5	4	2	#	#	#
Haze or Fog												
FLYING WEATHER (PERCENTAGE)												
Observations with ceilings < 2000 ft A/O visibility < 5 Miles	59	58	39	21	16	19	17	20	35	56	63	62
Observations with ceilings < 1500 ft A/O visibility < 3 Miles												
Observations with ceilings < 1000 ft A/O visibility < 2 Miles	30	30	14	6	3	5	4	6	14	27	28	32
Observations Below 300 ft A/O 3/4 Mile	7	9	3	1	1	2	1	1	4	12	8	10
TAKE OFF DATA												
Mean Vapor Press (in. hg)												
Temperature of Dew pt.												
39.95%. Pres Alt (feet)												
REMARKS												
DAYS WITH:												
Snowcover ≥ Trace	10	7	1	#	0	0	0	0	0	0	1	3
Snowcover ≥ 2"	4	5	#	0	0	0	0	0	0	0	0	#

NOTE: *Data not available **Less than 0.6 days, 0.6% or .06 in. as applicable.

TABLE 3-4

CLIMATIC DATA SUMMARY (STUTTGART)

CLIMATIC DATA SUMMARY							Station: Stuttgart, Germany					
Field Location: 48°41'N 09°12'E	Field Elevation: 1,296 Feet		YEARS of Record: 10 years							Date: Apr 64		
Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
TEMPERATURE												
Extreme Maximum	57	61	71	81	87	95	97	95	89	77	71	63
Mean Daily Maximum	36	37	49	57	65	70	74	73	68	57	45	38
Mean Daily Minimum	27	25	33	40	47	52	56	54	50	41	34	29
Extreme Minimum	-3	-15	6	22	28	38	44	39	34	20	12	2
Humidity Mean Monthly %	83	81	73	69	68	73	71	73	76	81	85	86
PRECIPITATION												
Mean Monthly Precipitation (inches) Snowfall (inches)	2.0	1.2	1.3	1.9	2.4	3.1	2.8	2.6	2.3	1.4	1.9	1.9
Mean No. of Days												
Precipitation	20	19	16	18	18	20	17	17	16	14	19	21
Measurable Snowfall	13	13	6	3	1	*	#	#	#	1	4	11
Thunderstorms	#	0	*	1	4	7	7	5	1	#	0	#
Haze or Fog												
FLYING WEATHER (PERCENTAGE)												
Observations with Ceilings <5000 ft A/O Visibility <3 Miles												
Observations with Ceilings <1500 ft A/O Visibility <3 Miles	38	40	16	11	7	5	6	5	11	24	32	44
Observations with Ceilings <1000 ft A/O Visibility <1 Miles												
Observations Below 400 ft A/O 1 Mile	9	4	3	1	1	1	1	1	4	#	6	11
TAKE OFF DATA												
Mean Vapor Press. (In Hg)												
Temperature of Dewpt.												
99.95% Pres. Alt (ft)												
REMARKS:												
DAYS WITH:												
Snowcover ≥ Trace	12	11	4	1	0	0	0	0	0	#	3	10
Snowcover ≥ 2"	8	10	1	*	0	0	0	0	0	0	2	6

Note. * Data not available. # Less than 0.6 days, 0.6% or .06 in. as applicable

TABLE 3-5

CLIMATIC DATA SUMMARY (KARLSRUHE AAF)

CLIMATIC DATA SUMMARY							Station: Karlsruhe AAF, Germany					
Field Location 49° 01'N 08° 23'E	Field Elevation: 375 Feet		YEARS of Record 10 to 50 Years							Date Apr 64		
Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
TEMPERATURE												
Extreme Maximum	61	67	75	84	94	92	101	97	90	81	68	67
Mean Daily Maximum	38	42	50	58	67	73	75	74	67	56	46	40
Mean Daily Minimum	29	30	35	41	48	54	57	56	51	43	36	31
Extreme Minimum	-10	-10	5	21	28	38	43	41	31	21	9	1
Humidity Mean Monthly %	84	80	75	70	70	71	72	75	81	84	85	86
PRECIPATION												
Mean Monthly Precipitation (inches) Snowfall (inches)	2.0	1.7	2.1	2.3	2.2	2.8	3.0	3.1	2.9	2.6	2.4	2.6
Mean No. of Days												
Precipitation	15	14	15	15	14	14	14	15	13	14	14	17
Measurable Snowfall	6	5	4	1	#	0	0	0	0	#	2	4
Thunderstorms	#	#	1	2	6	10	10	7	3	1	0	*
Haze or Fog												
FLYING WEATHER (PERCENTAGE)												
Observations with ceilings < 5000 ft A/O visibility < 5 Miles												
Observations with ceilings < 1500 ft A/O visibility < 3 Miles												
Observations with ceilings < 1000 ft A/O visibility < 1 Mile	19	18	8	5	2	3	2	3	6	22	23	30
Observations with ceilings 500 ft A/O 1 Mile	14	13	5	2	1	2	1	2	5	18	17	22
TAKE OFF DATA												
Mean Vapor Press (in. hg)												
Temperature of Dew pt.												
39.95% Pres. Alt (Feet)												
REMARKS:												
DAYS WITH:												
Snowcover ≥ Trace	12	7	2	#	0	0	0	0	0	0	#	2

NOTE: *Data not available ** Less than 0.6 days, 0.6% or .06 in. as applicable

TABLE 3-6

CLIMATIC DATA SUMMARY (FUERSTENFELDBRUCK)

CLIMATIC DATA SUMMARY								Station: Fuerstenfeldbruck, Germany				
Field Location: 48°12'N 11°16'E	Field Elevation: 1,698 Feet		YEARS of Record: 9 Years							Date: Apr 64		
Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
TEMPERATURE												
Extreme Maximum	61	61	73	79	89	93	95	97	89	75	63	59
Mean Daily Maximum	34	36	47	57	65	70	74	73	68	56	44	36
Mean Daily Minimum	23	24	31	38	46	52	55	54	49	39	33	27
Extreme Minimum	-9	-3	4	22	28	36	40	38	33	20	10	0
Humidity												
Mean Monthly %	83	79	72	68	66	68	67	70	76	81	84	85
PRECIPITATION												
Mean Monthly												
Precipitation (inches)	2.1	1.8	1.7	2.0	2.9	3.9	4.9	3.2	2.6	1.4	2.4	1.7
Snowfall (inches)												
Mean No. of Days												
Precipitation	21	21	18	18	19	19	17	17	16	14	18	20
Measurable Snowfall	16	15	9	4	1	#	#	0	#	1	5	13
Thunderstorms	0	0	0	2	7	6	4	4	1	0	0	0
Haze or Fog												
FLYING WEATHER (PERCENTAGE)												
Observations with Ceilings <2500 ft A/O Visibility <3 Miles	65	63	40	26	22	21	18	18	30	52	64	71
Observations with Ceilings <1500 ft A/O Visibility <3 Miles	45	42	27	14	11	10	9	9	15	33	44	54
Observations with Ceilings <1000 ft A/O Visibility <2 Miles												
Observations Below 500 ft A/O 1 Mile	17	16	7	3	2	1	1	2	6	15	19	25
TAKE OFF DATA												
Mean Vapor Press. (in. Hg)												
Temperature of Dewpt												
99.95% Press Alt (ft)												
REMARKS:												
MEAN NO. DAYS WITH:												
Snowcover ≥ Trace	21	17	7	1	0	0	0	0	0	#	4	14
Snowcover ≥ 2"	9	9	3	0	0	0	0	0	0	#	1	3

NOTE: * Data not available # Less than 0.5 days, 0.5% or .05 in. as applicable

△ Stations (six) used for Climatic Data Summary

□ Stations (seven) used for Cloud Cover and Visibility Analysis

Figure 3-2 Weather Stations of Central Europe

The synoptic data consist of observations for seven days in the last week in the month of May for one year (1964) only. This sample of data is small and therefore represents only an average day for this short period of time. The cloud cover analysis is presented in Figures 3-3 to 3-9 and the visibility analysis in Figures 3-10 to 3-16. The illumination for Central Europe, for late May, is shown in Figure 3-17.

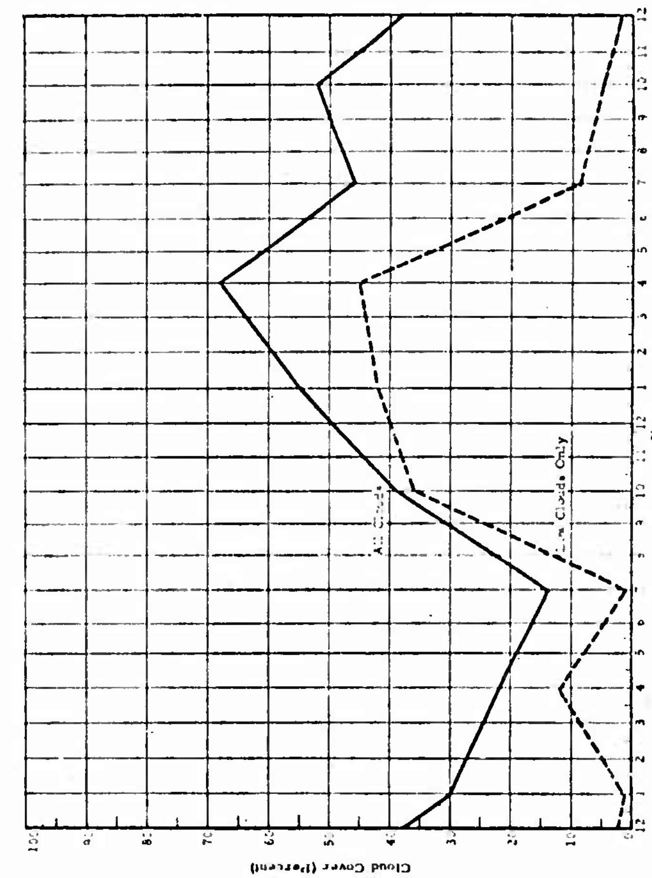


Figure 3-3 Cloud Cover for Prague/Ruzyně, Czec slovakia

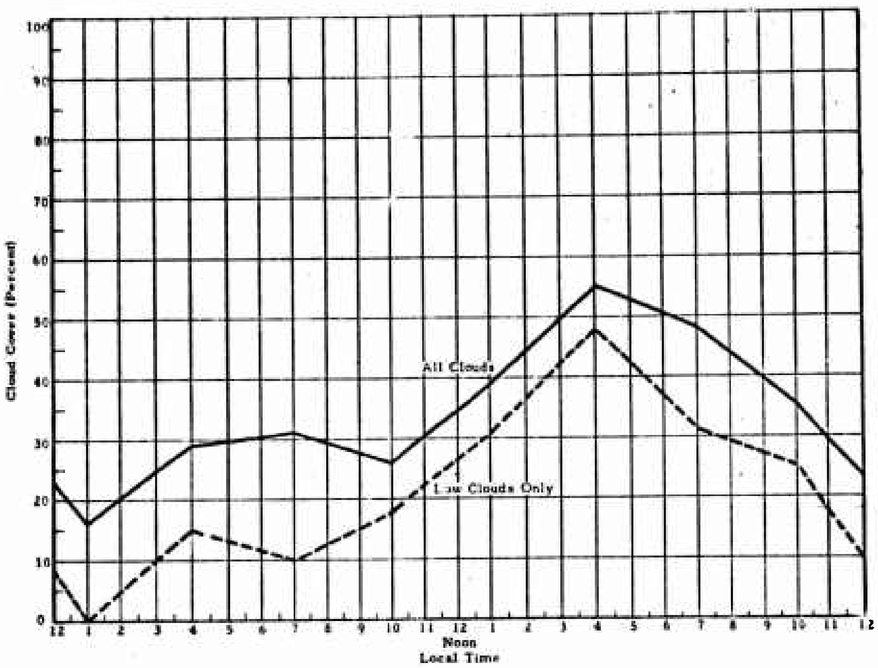


Figure 3-4 Cloud Cover for Dresden/Klotzsche, Germany (East)

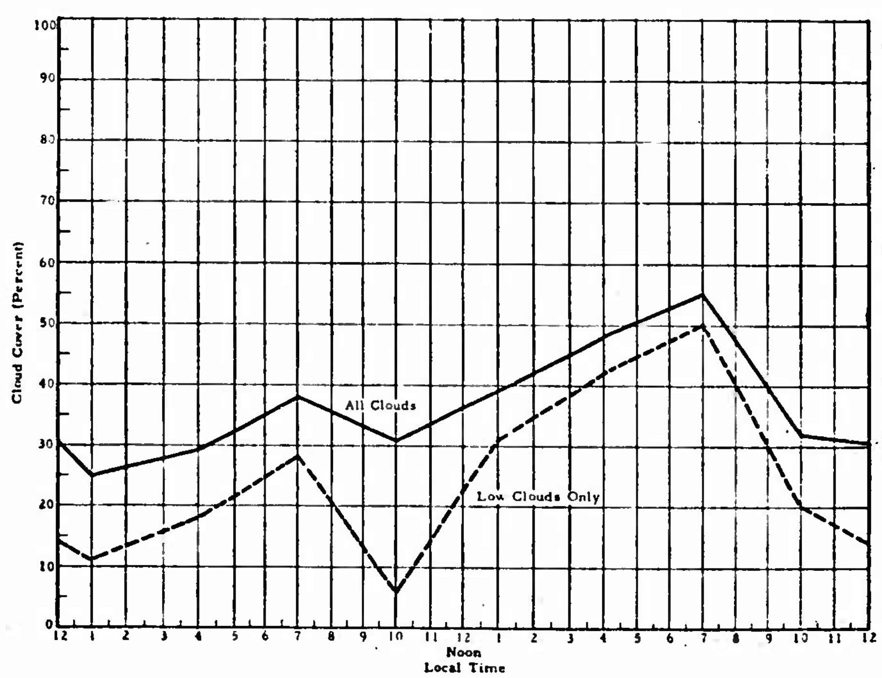


Figure 3-5 Cloud Cover for Magdeburg, Germany (East)

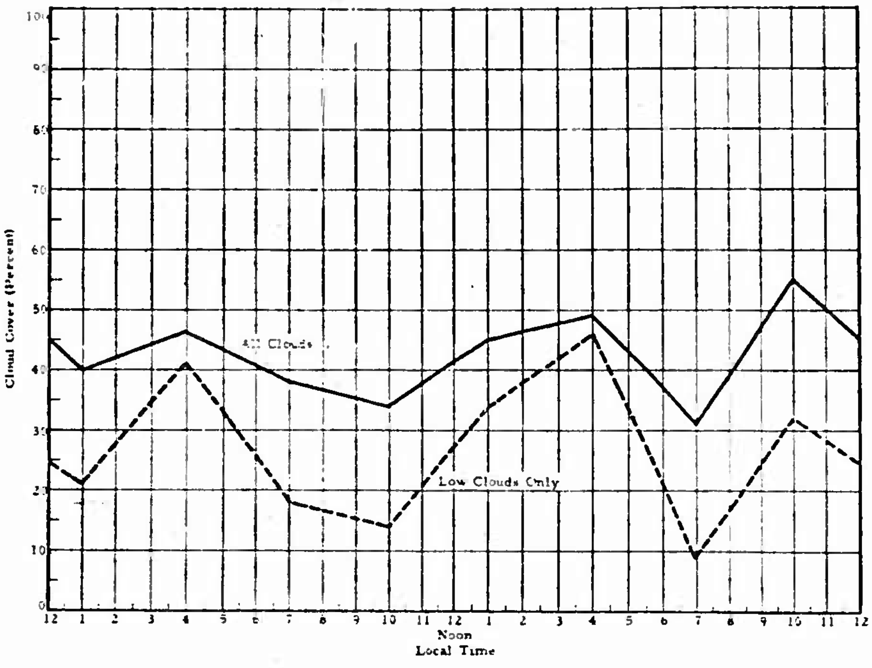


Figure 3-6 Cloud Cover for Kassel, Germany (West)

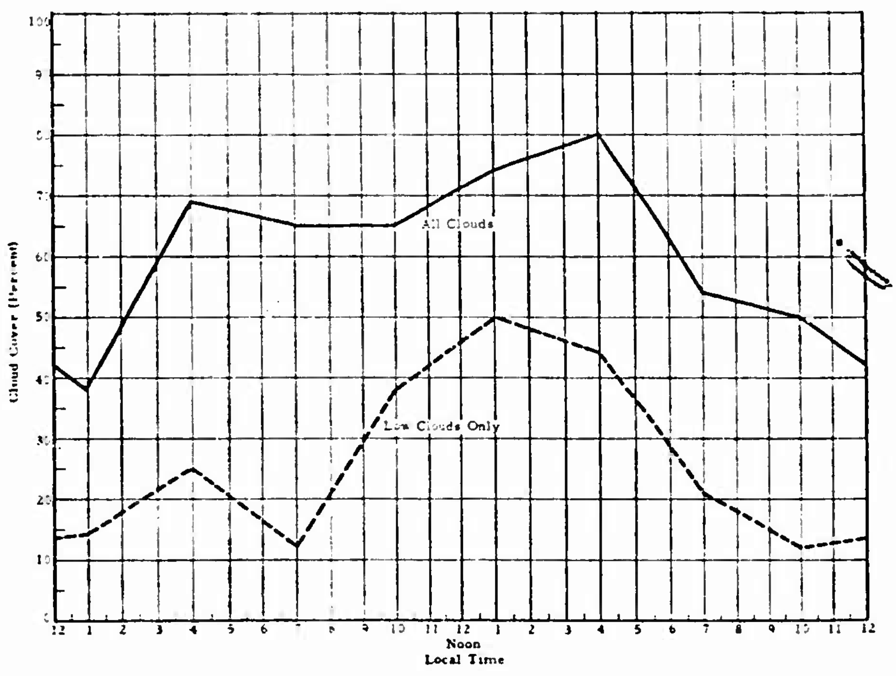


Figure 3-7 Cloud Cover for Rhein/Main, Germany (West)

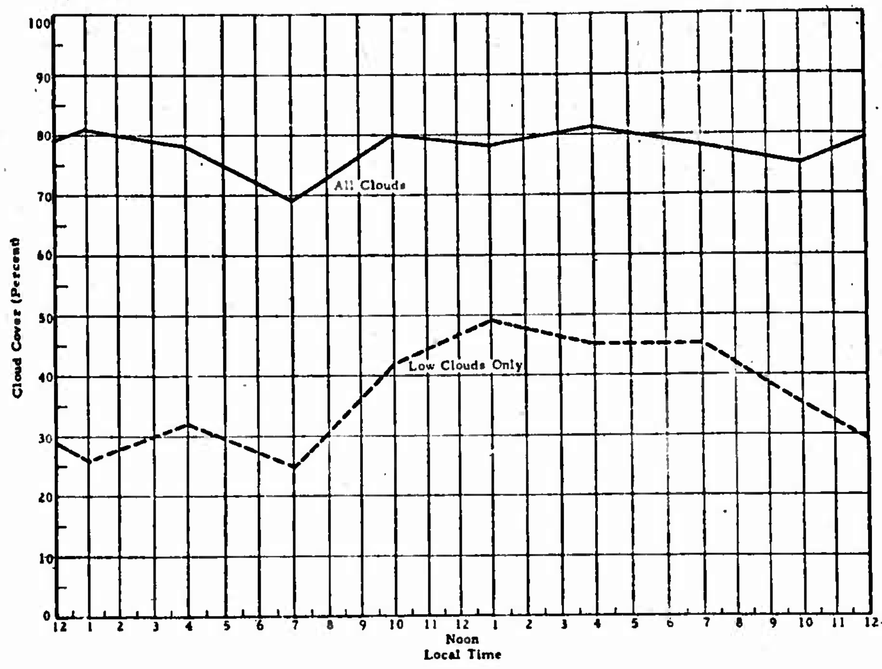


Figure 3-8 Cloud Cover for Wasserkuppe, Germany (West)

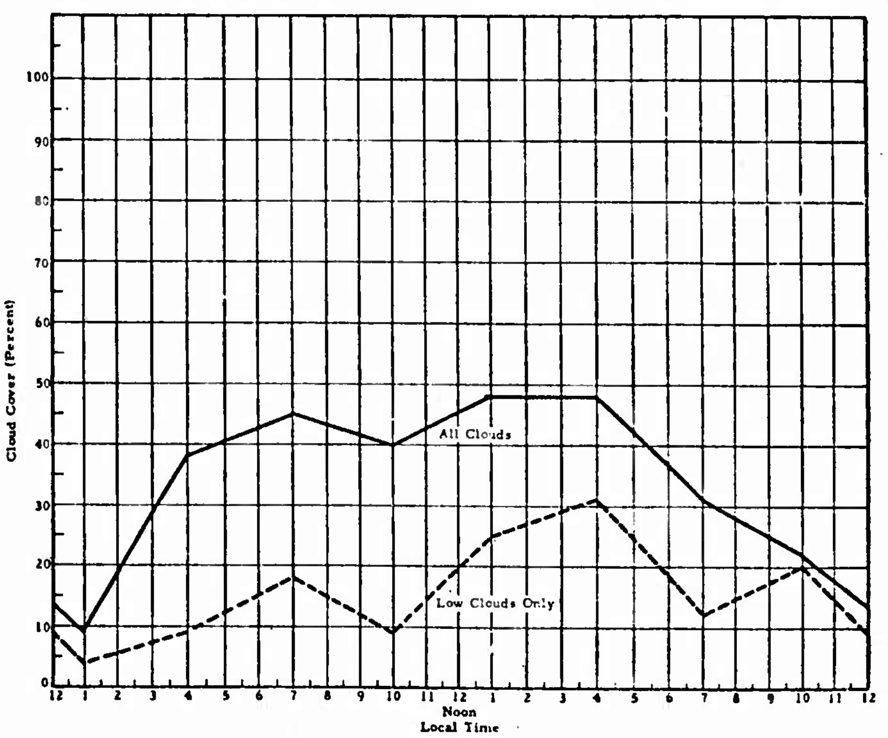


Figure 3-9 Cloud Cover for Zielona Góra, Poland

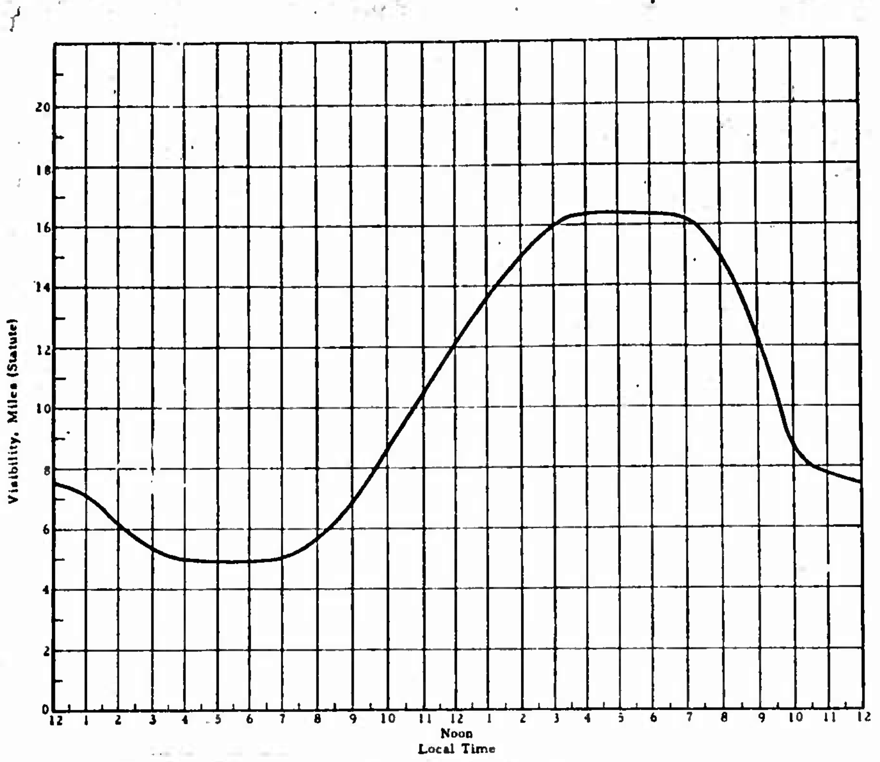


Figure 3-10 Visibility for Prague/Ruzyně, Czechoslovakia

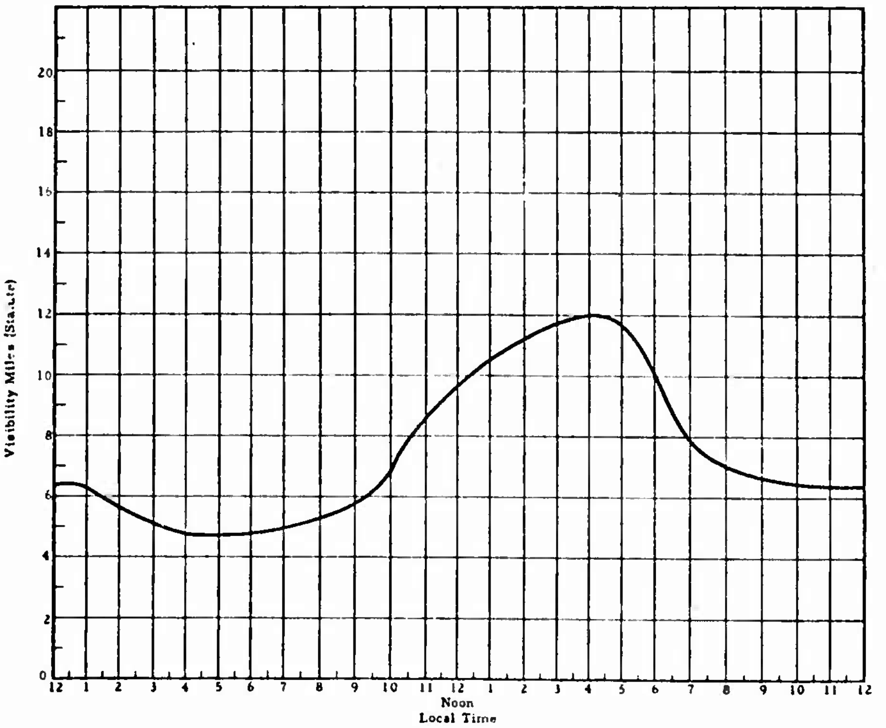


Figure 3-11 Visibility for Dresden/Klotzsche, Germany (East)

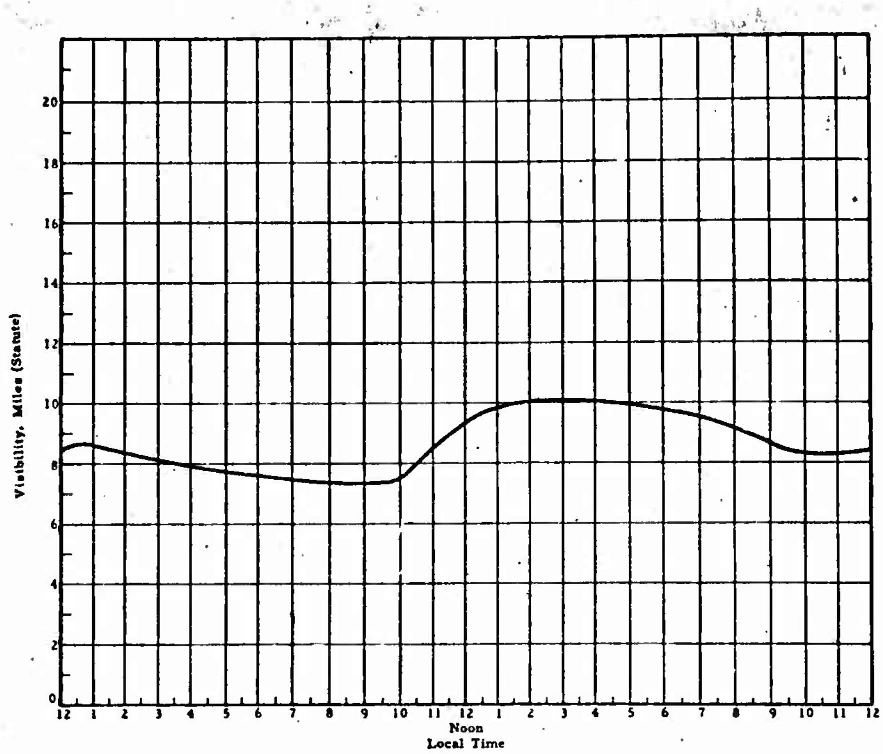


Figure 3-12 Visibility for Magdeburg, Germany (East)

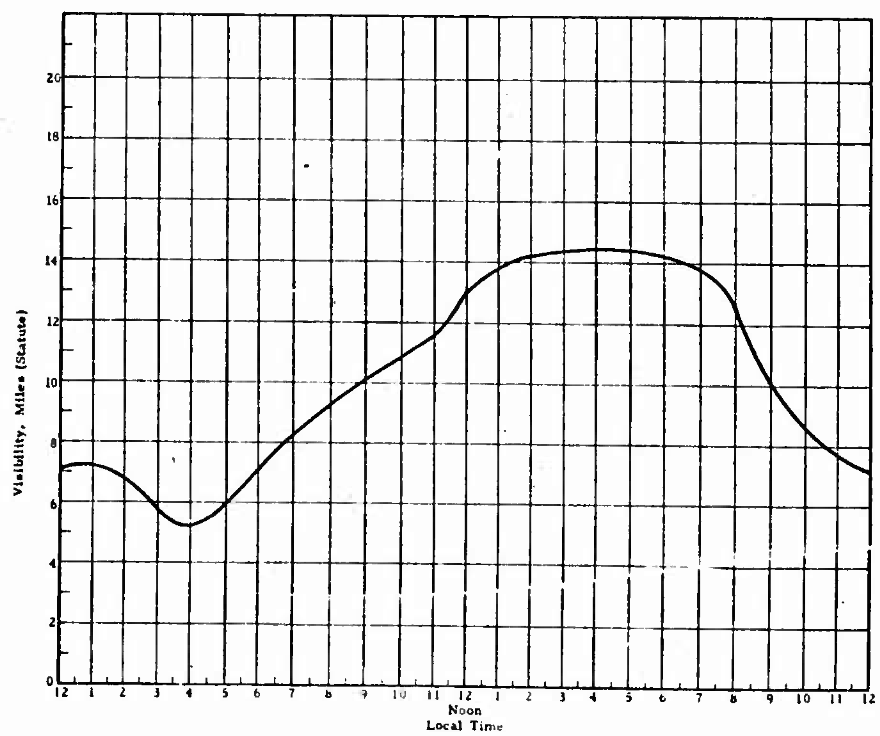


Figure 3-13 Visibility for Kassel, Germany (West)

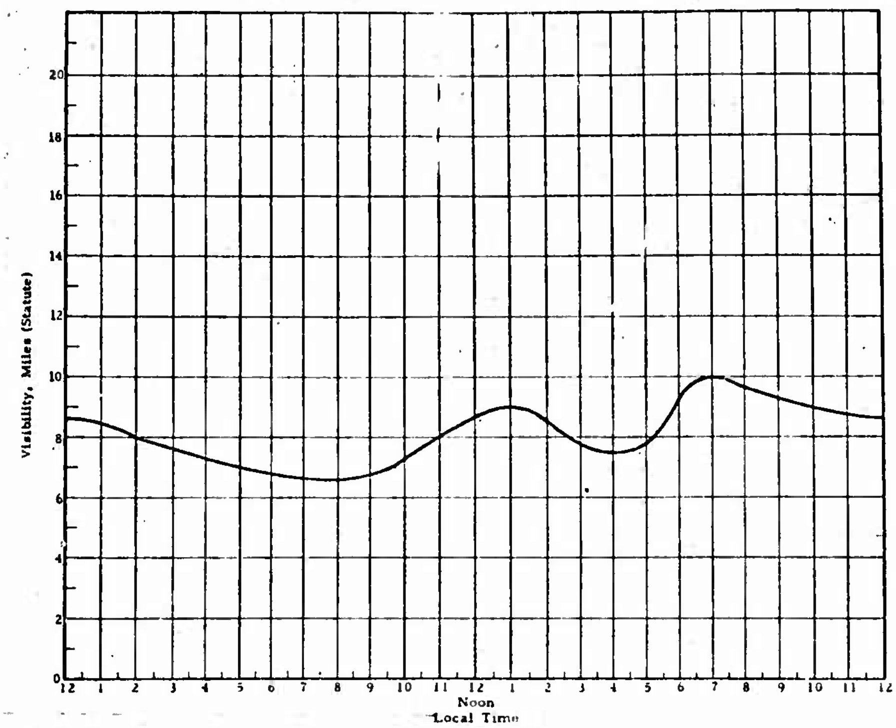


Figure 3-14 Visibility for Rhein/Main, Germany (West)

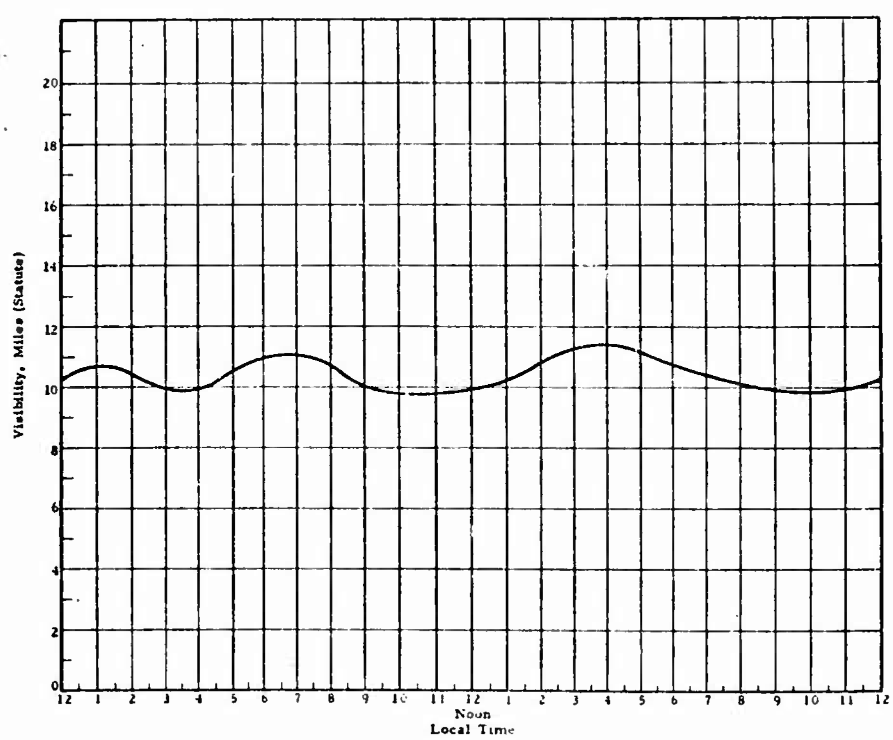


Figure 3-15 Visibility for Wasserkuppe, Germany (West)

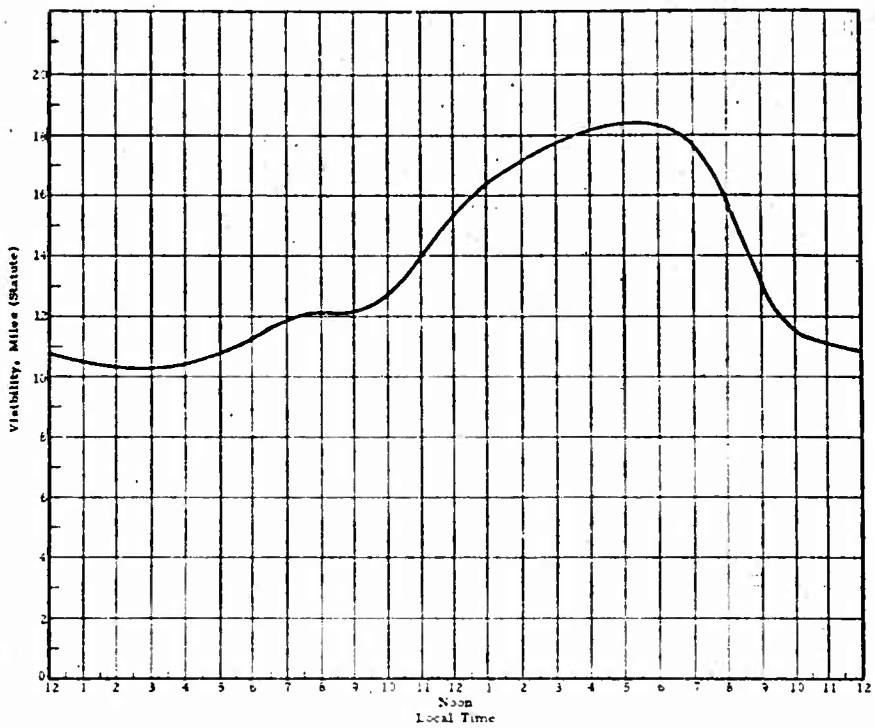


Figure 3-16 Visibility for Zielona Gora, Poland

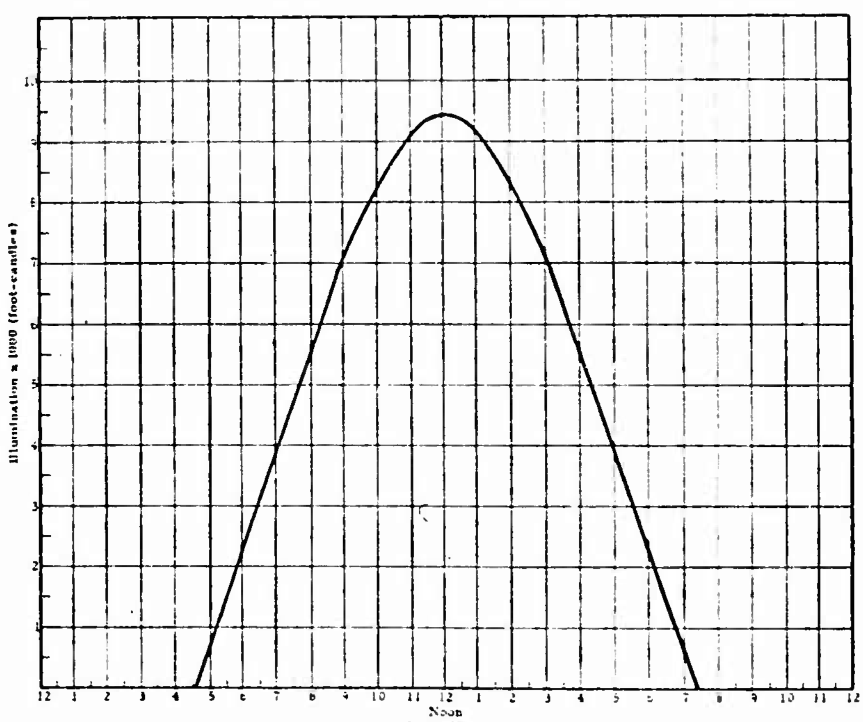


Figure 3-17 Illumination for Central Europe for Late May—50°N

SECTION 4

TOPOGRAPHY, VEGETATION AND CLIMATE OF AFRICA

Africa is the second largest continent in the world with an area of 11,635,000 square miles (sq mi) and spanning a distance of 4970 miles north to south and 4700 miles east to west. The coastline is 18,900 miles long with very few breaks in the shoreline that would provide good harbors.

The terrain is that of a generally monotonous, level or gently undulating continent of plateaus. There are two basic physiographic regions, the Atlas mountains of the northwest and the African plateau embracing the remainder of the continent. The plateau area is also made up of two physiographic provinces. The low (less than 3500-ft elevation) plateau which covers most of northern, western, and central Africa and the high (over 3500-ft elevation) plateau of southern, eastern and northeast Africa. Transportation is impeded by a deep "rift valley" stretching north to south from Ethiopia to Mozambique.

Africa has six large rivers—the Nile, Congo, Lanpopo, Niger, Orange, and Zambesi. Africa is hot and dry (except for the tropical areas). Thirty-nine percent is desert wasteland and 33% is so dry that agriculture is prevented over a 3-6 month period each year.

The high and low plateau areas are shown on a relief map (Figure 4-1). Agricultural resources are shown by a soil map (Figure 4-2), a vegetation belt map (Figure 4-3), and a map of natural vegetation (Figure 4-4). Climatic conditions are shown in Figures 4-5 through 4-10.

4.1 TOPOGRAPHY, VEGETATION, AND CLIMATE OF THE CONGO

4.1.1 Topography

The Congo territory (Figure 4-11) has direct access to the sea at the Congo River mouth. The area is 905,418 sq mi, with a boundary line of 5728 mi of which only 25 mi are on the seaboard. The Congo-Zambesi watershed forms the boundary with Northern Rhodesia.

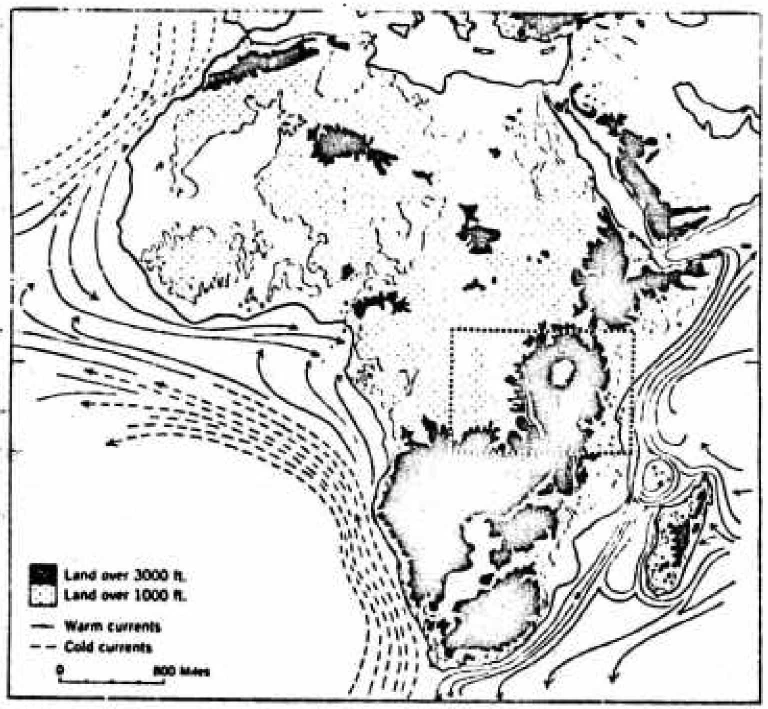


Figure 4-1 Relief Map of Africa

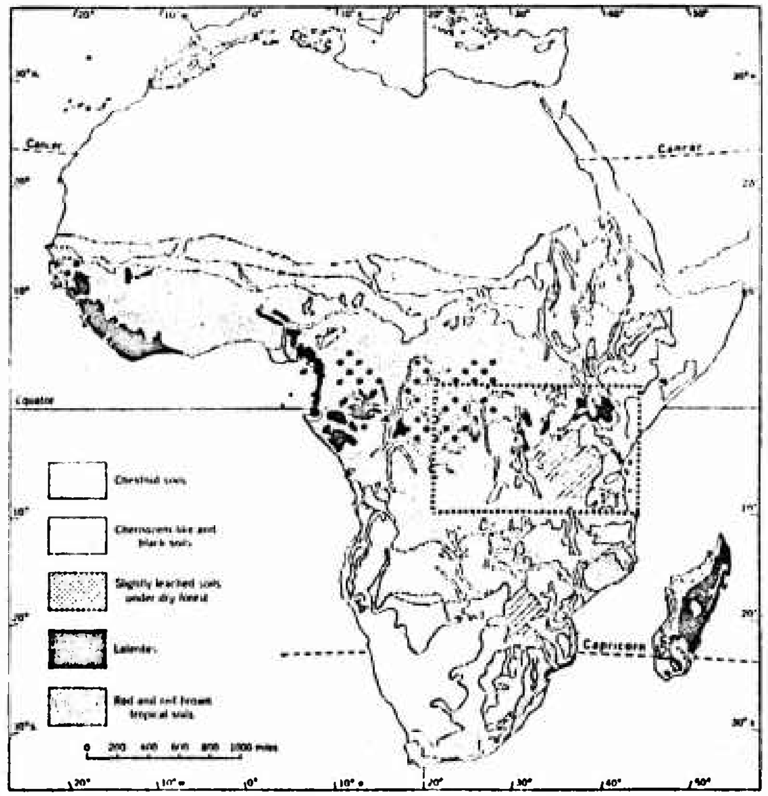


Figure 4-2 Soil Map of Africa

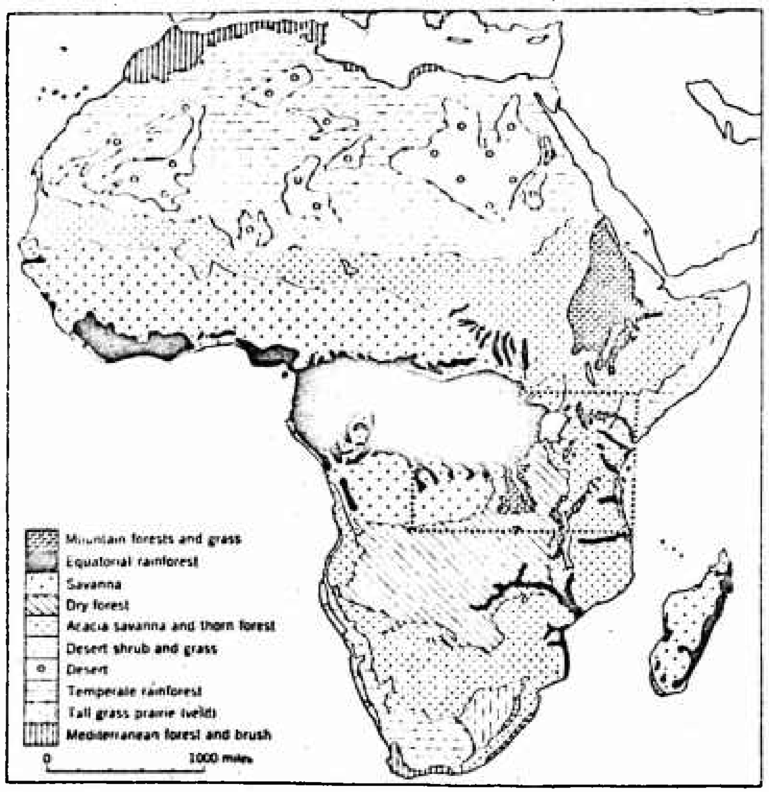


Figure 4-3 Main Vegetation Belts of Africa

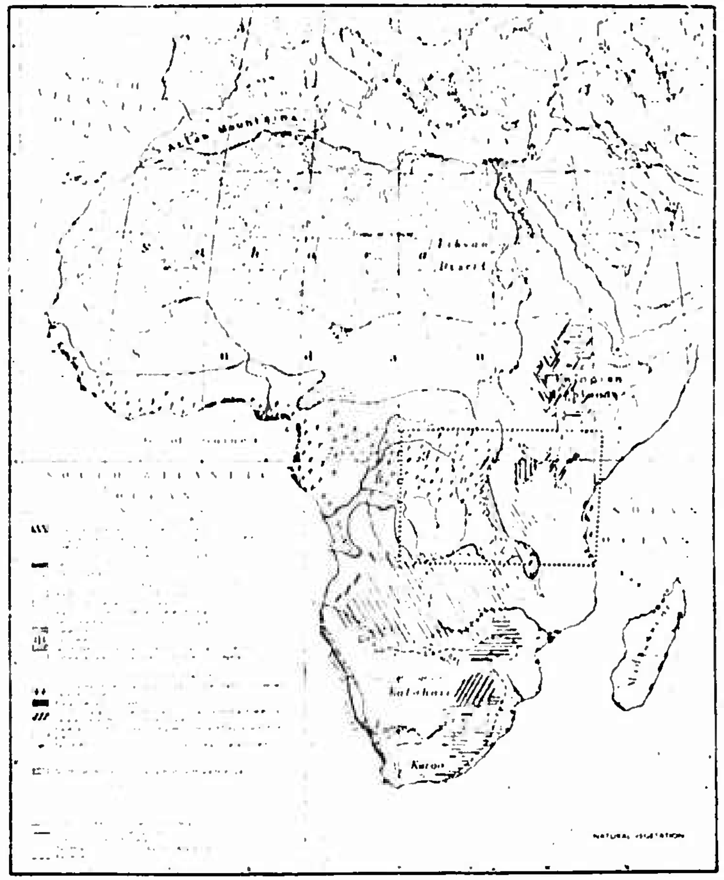


Figure 4-4 Natural Vegetation

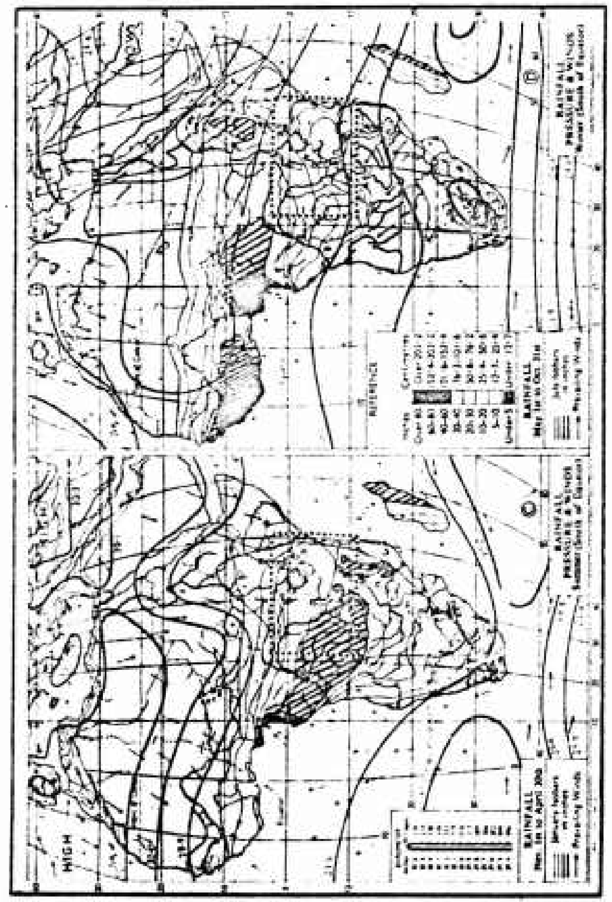


Figure 4-5 Rainfall, Pressure, and Winds

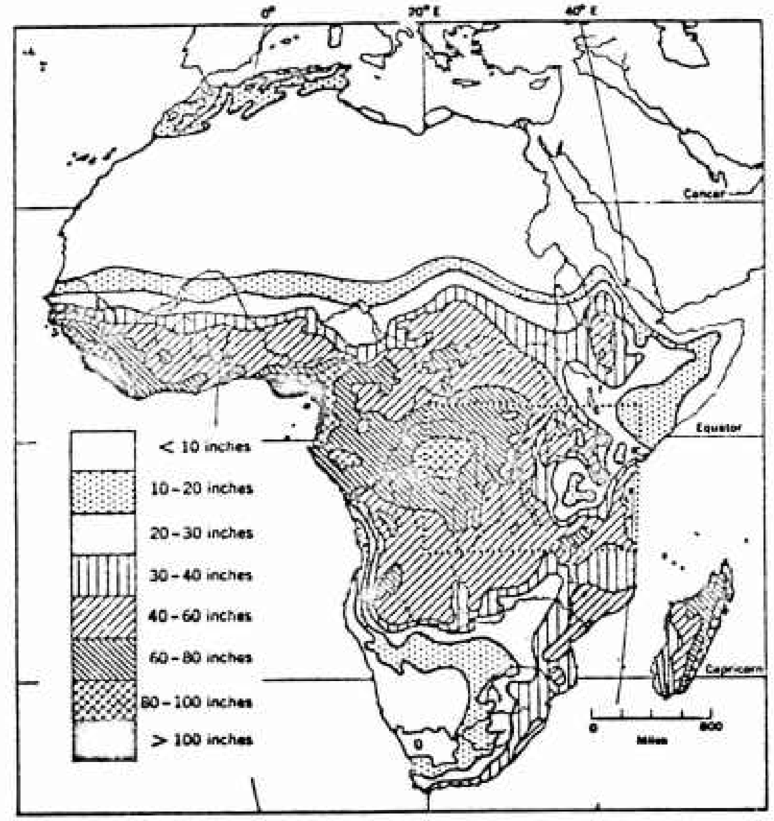


Figure 4-6 Average Annual Rainfall

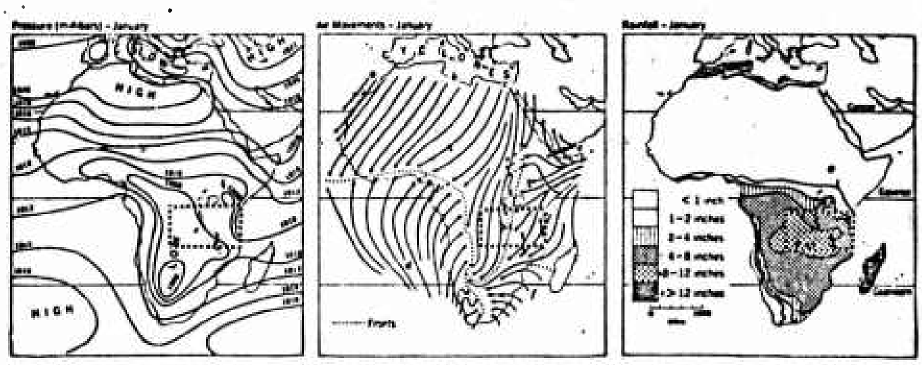


Figure 4-7 Climatic Conditions Over Africa in January

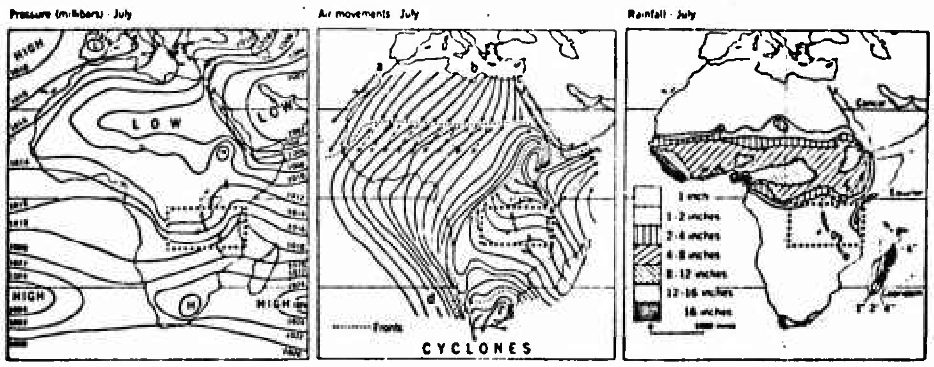
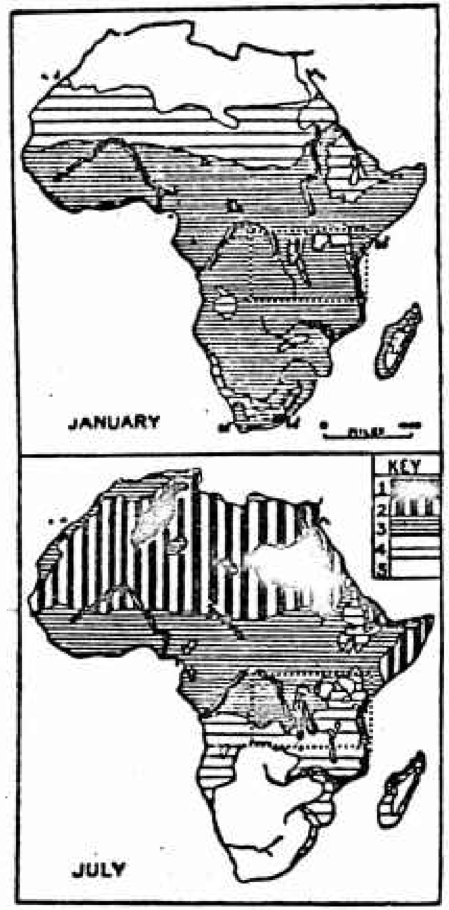


Figure 4-8 Climatic Conditions Over Africa in July



1. Over 90°F
2. Between 80 and 90°F
3. Between 70 and 80°F
4. Between 60 and 70°F
5. Less than 60°

Figure 4-9 Actual Mean Temperatures for January and July

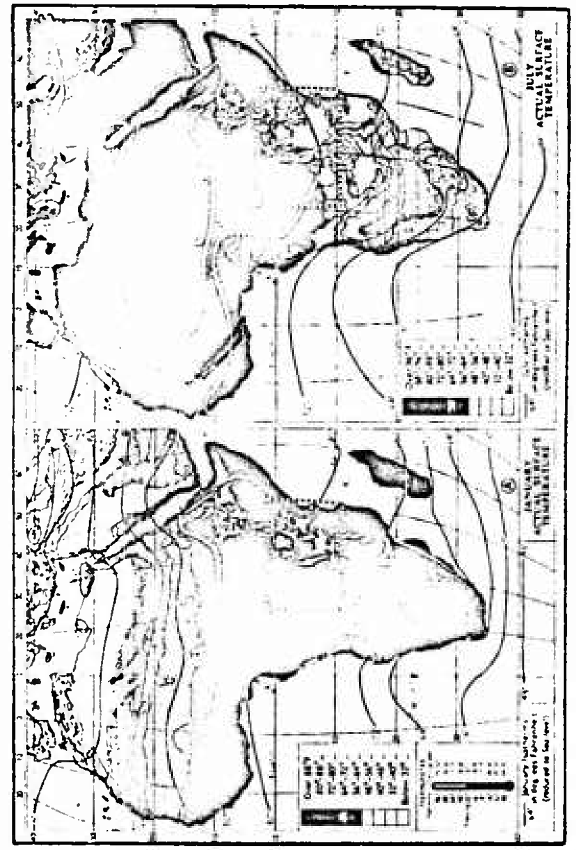


Figure 4-10 Surface Temperature Gradients

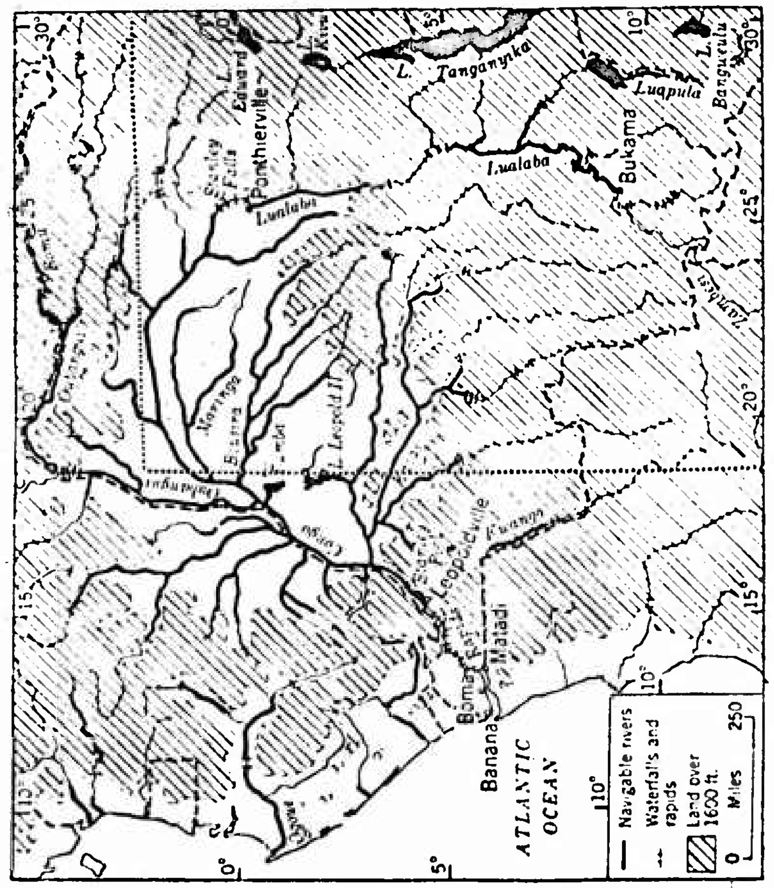


Figure 4-11 Congo Basin Waterways

The principal lakes are Lake Tanganyika, much of whose coastline is in Congo territory and which has an area of 10,965 sq mi; Lake Albert, with an area of 2162 sq mi; Lake Edward, with an area of 830 sq mi; and Lake Kivu, 4829 ft above sea level, 62 mi long, and 856 sq mi in area.

The main Congo River and its left-bank affluents, notably the Kasai, have two periods of low water alternating with phases of flood or high water, in contrast to the right-bank tributaries, particularly the Ubangi, where a single rise and fall is the rule.

The first maximum in the year occurs about the middle of May in consequence of the high level of the rivers in the southern part of the basin (upper Kasai and Southern Katanga). Afterwards the level of the upper Congo falls continuously until July when, for example, there is low water at Stanleyville near Stanley Falls. In the same month (July), however, the lower middle river is raised by the floods of the Ubangi and the other right-bank tributaries. Still farther downstream at the mid-year the Congo receives little water from any of its affluents—it is a time when the Kasai is low—and at Stanley Pool the great river is at its lowest in July and August.

The second maximum in the regime of the Congo occurs about the middle of December. This is due not so much to the flood from the right-bank entrants (Ubangi, Sangha, etc) which attain their single maximum much earlier, in October, but to the early summer floods (late November and early December) on the upper Congo system (Lualaba, etc) that occur when there is still a considerable volume of water in the northern right-bank rivers, then beginning their winter low-level regimes.

4.1.2 Vegetation

Nearly one-half of the total land area is covered by woodland (see Figure 4-12), more than 25,000 sq mi of which is tropical rain forest. The woodlands of the Central Basin, up to 250 mi wide, stretch for more than 750 mi along the equator. With the exception of the Mayumbe Forest in the coastal district and the woodlands of southeast Katanga, the rain forests are almost entirely confined to the most central and easterly districts.

The forests, always green because there is no dry season, are made dense and luxurious by the extreme heat and moisture. The undergrowth is scant because the dense canopy formed by the treetops keeps the sun from reaching the forest floor.

1. Forest
2. Woodland Savanna
3. Dry Savanna
4. Marshland

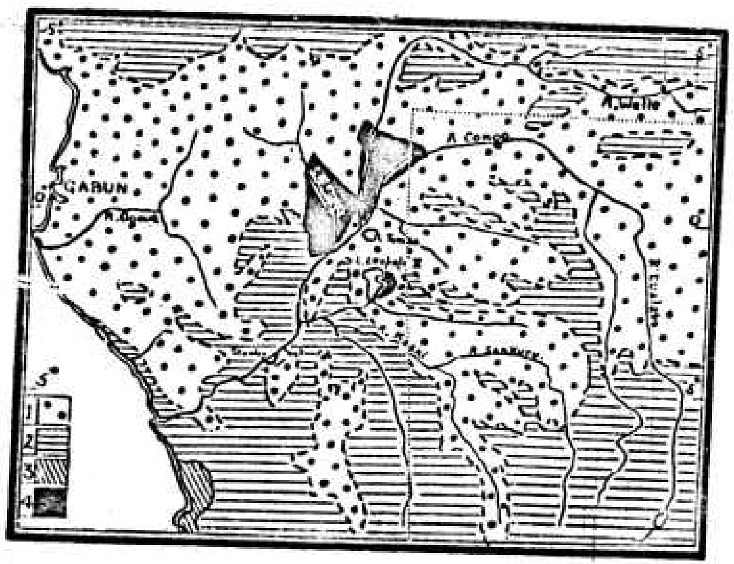


Figure 4-12 Vegetation in the Congo Basin

With the exception of the woodland savanna of southeast Katanga, open forests and park-like savannas cover most of the southern half of the country and the northern border area. In the hot rainy season, the grasses, flowers, scattered trees, and shrubs burst into bloom and grow vigorously, but in the dry season the land is parched and barren. Studding the landscape are giant ant and termite hills many feet high, so massive that they are left standing in the middle of cultivated plots and roads are curved around them.

A typical savanna during the rainy season has several varieties of long grasses and numerous shrubs, as well as many coconut palms and banana trees. Grass sometimes grows several feet high.

4.1.3 Climate

North of the equator, the rainy season lasts from 1 April to 30 October and the dry season from 1 November to 30 March. There is, however, a great deal of variation.

The Central Basin (south of the equator) has approximately 60 to 80 in. of rain in the middle, decreasing to 40 to 60 in. at the edges. It rains on about 130 days in the year.

A line of violent and sometimes destructive winds—known as line squalls and appearing simultaneously over a large area—is a fairly frequent event in all parts of the region (Central Basin); at the height of the rainy season, they may occur as often as 10 times a month.

At the equator, temperatures range from 60 to 100° but are usually close to 90°. The hottest month is February. Humidity is always high, ranging upward from 65%. The average temperature on the edge of the basin is about 77°. Since temperature varies with elevation, however, at 5000 ft the average may be 65° while at the same latitude at 13,000 ft it is only 43°. In some areas around the basin nights are colder; white frosts are fairly frequent in Katanga during the dry season.

Because of the relationship of the earth's axis to the plane of its path around the sun, the hours of daylight in the tropics remain practically unchanged throughout the year. The longest day has no more than 13 hr of sunlight and many inland places in the basin receive fewer than 2000 hr a year, or less than any inland area in the US.

The fierceness of the sun's rays in most parts of the country is partially cut off, even in cloudless weather, by an atmospheric screen of dust and smoke in the dry season and by invisible moisture particles in the rainy periods. The monotony of high temperatures and high humidity often makes the climate uncomfortable. In Katanga and among the mountain valleys and lakes of Kivu, temperatures are generally lower and there is more seasonal variation.

4.1.4 Detailed Climatology Analysis of the Congo

The average daily July cloud cover for Kamina Baka and Stanleyville is shown in Figures 4-13 and 4-14, respectively. The average daily July visibility for Kamina Baka and Stanleyville is shown in Figures 4-15 and 4-16, respectively.

4.2 TOPOGRAPHY, VEGETATION, AND CLIMATE OF TANGANYIKA

4.2.1 Topography

Tanganyika (Figure 4-17) extends from the Umba River on the north to the Rovuma River on the south, the coastline being some 500 mi long, and includes the adjacent islands (except Zanzibar and Pemba). The northern boundary runs northwest to Lake Victoria at the intersection of the first parallel of southern latitude with the eastern shore. The boundary on the west follows the Kagera River (the eastern frontier of Rwanda), thence the eastern boundary of Burundi to Lake Tanganyika. The western boundary then follows the middle of Lake Tanganyika to its southern end at the Kalambo River 50 miles south of Kasanga, whence it goes southeast to the northern end of Lake Nyasa. It follows its eastern shore and rather less than halfway down the lake turns east and joins the Rovuma River whose course it follows to the sea. The total area is 361,800 sq mi (937,060 sq km), which includes 20,650 sq mi (53,480 sq km) of water.

The country is divided into 17 regions (with capitals of the same name, unless added in brackets): Arusha, Coast (Dar es Salaam), Dodoma, Iringa, Kigoma, Kilimanjaro (Moshi), Mara, Mbeya, Morogoro, Mtwara, Mwanza, Ruvuma (Songea), Shinyanga, Singida, Tabora, Tanga, West Lake (Bukoba).

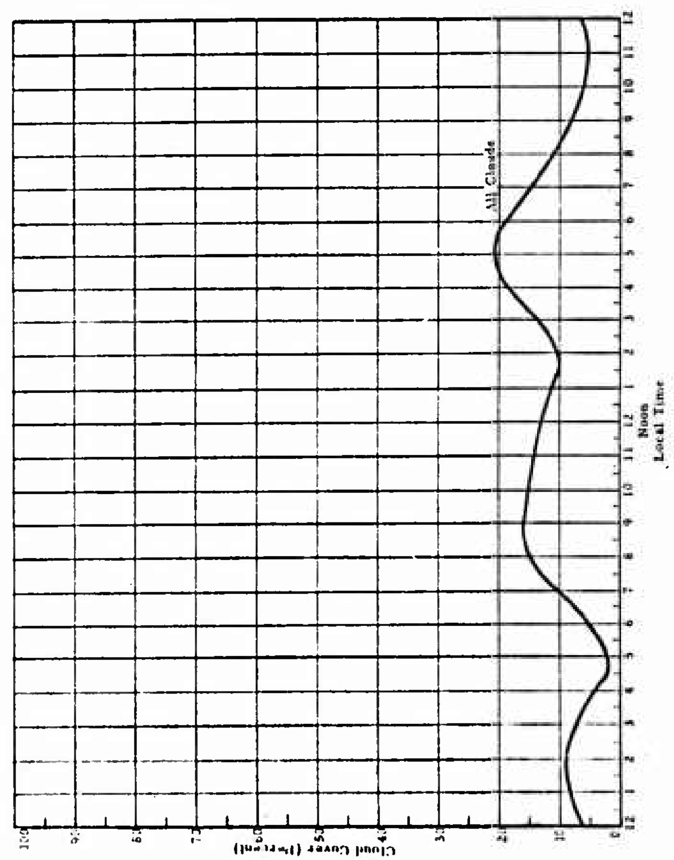


Figure 4-13 Average Cloud Cover for July at Kamina Baka, Congo

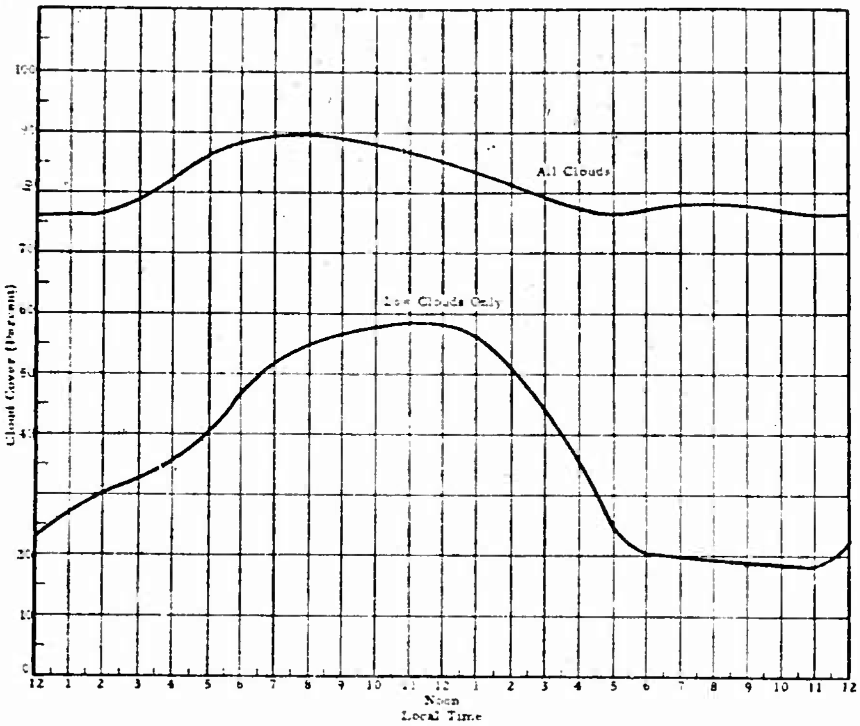


Figure 4-14 Average Cloud Cover for July at Stanleyville, Congo

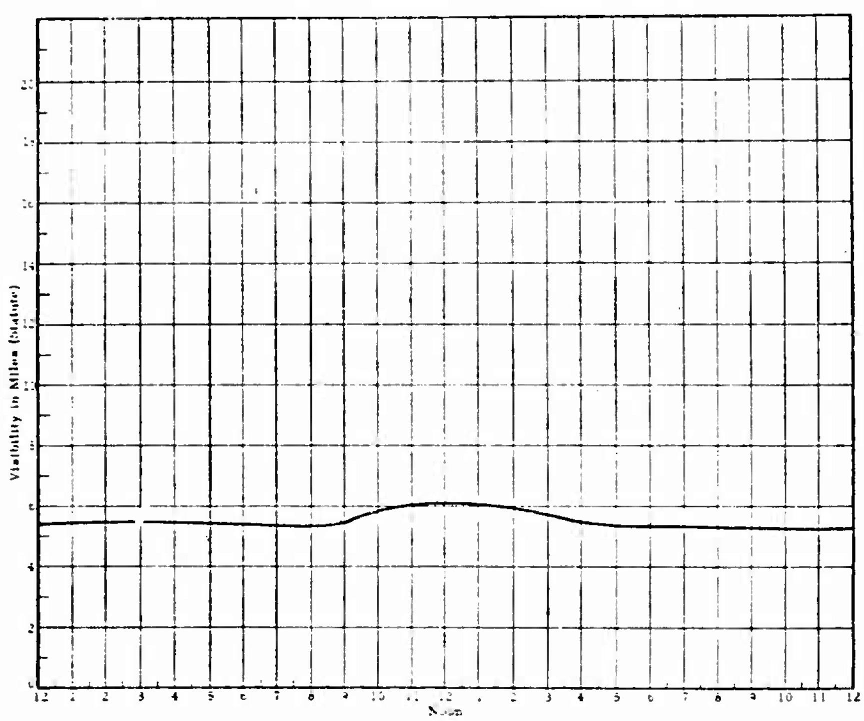


Figure 4-15 Average Visibility for July at Kamina Baka, Congo

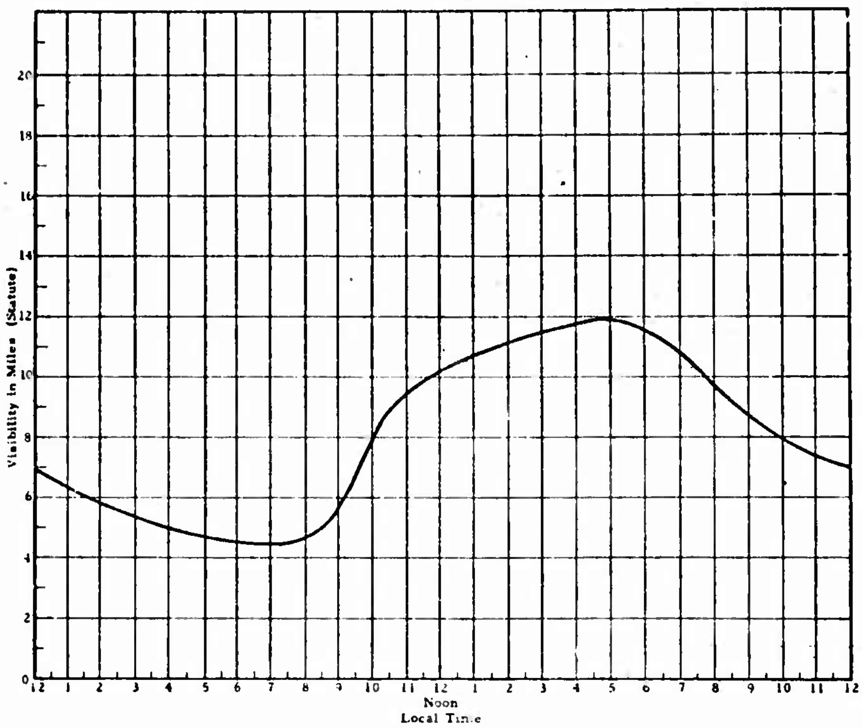


Figure 4-16 Average Visibility for July at Stanleyville, Congo

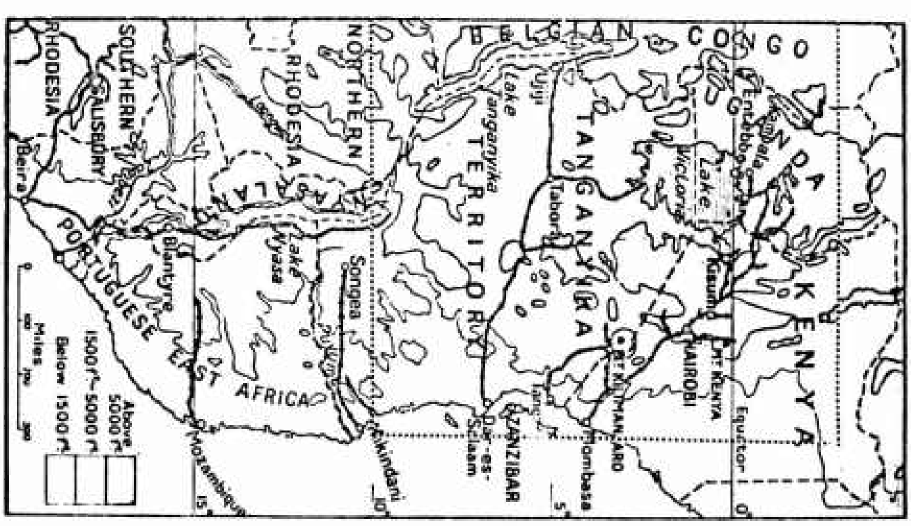


Figure 4-17 Tanganyika

The southern portion of Lake Victoria and portions of the eastern sides of Lakes Tanganyika and Nyasa are included in the Tanganyika Territory. There are also some smaller lakes such as Rukwa, Natron, etc. There are numerous rivers such as Pangani, Rufiji, and Rovuma. Rovuma forms the southern boundary with Portuguese East Africa.

Mount Kilimanjaro, whose height is 19,340 ft above mean sea level, lies in the north. This mountain is an extinct volcano and is permanently snow covered. It is the highest mountain in Africa.

4.2.2 Vegetation

The closed forests of Tanganyika are but a remnant of those of the past. They cover some 15,457 sq mi and are found mainly in the high rainfall areas of the main mountain masses and in parts of the Lake Victoria basin (Figure 4-18). These closed forests are of value not only as a source of timber, poles, firewood, and minor forest products, but also because of their important influence on climate, soil, and stream flow.

Supplementing the closed forests as sources of forest produce are vast areas of land, mostly at lower elevations, covered with an open type of woodland known as miombo. In the aggregate, the miombo contains a great quantity of valuable timber, scattered as single trees and groups of trees among numerous less useful species.

4.2.3 Climate

Climatically the territory may well be divided into four areas: (1) coastal plains, (2) Central Plateau, (3) lake regions, and (4) highland areas (rising up from the central plateau). In all areas, well defined wet and dry seasons prevail. (Figure 4-19.)

Heat and humidity are characteristic of the climate of the coastal plains. Cool and pleasant conditions are usual from June to August with low humidity and little cloud. Night temperatures may fall below 60°F and maximum day temperatures are between 80° and 85°F. Areas farther from the coast, at an altitude of about 1500 ft above sea level, experience high temperatures, but with a lesser degree of humidity and comparatively cool nights. (Figure 4-20.)

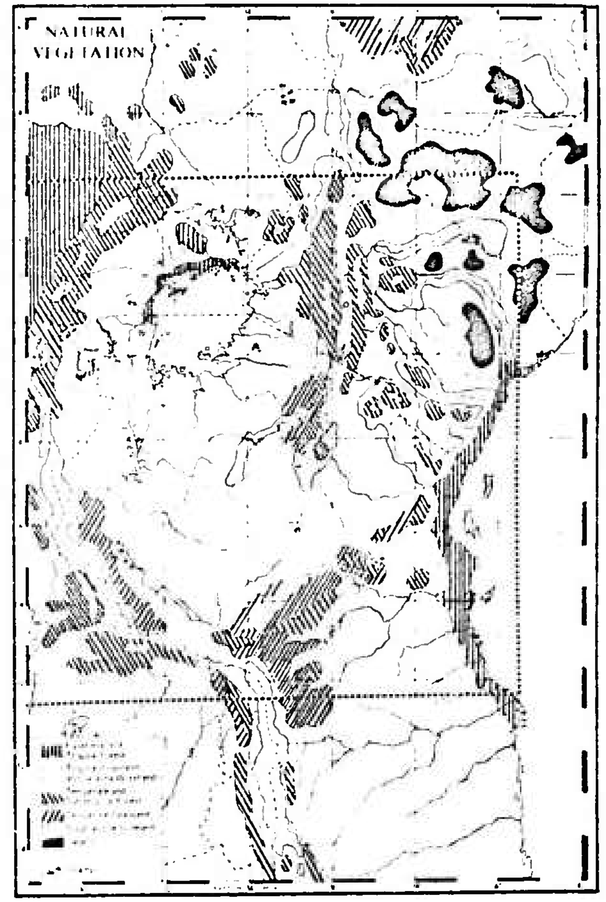


Figure 4-18 Natural Vegetation

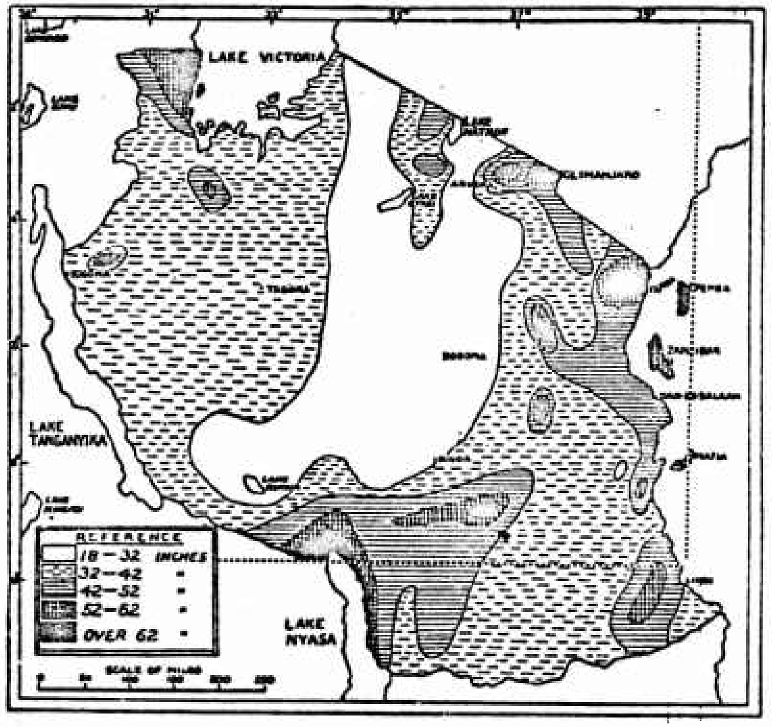


Figure 4-19 Tanganyika Territory: Distribution of Mean Annual Rainfall

Figure 4-20 Annual Actual Temperature

The hot and arid zone of the Central Plateau, with an altitude varying from about 2000 to 4000 ft, has a climate with considerable daily variations of temperature (at Tabora sometimes exceeding 36°F daily) and differs greatly according to locality. The climate is not so trying as that of the coast for the nights are almost invariably cool.

The lake regions have an average height of about 4000 ft and are moister and more humid than the Central Plateau.

The highland areas northwest of Tanga (altitude 5000 to 10,000 ft) have a decidedly temperate climate, although frosts are unusual. The nights are often exceedingly cold and the air can be delightfully cool and invigorating even during the warmer months. The rainfall varies from about 40 to 80 in. or more per annum.

The area north, and northeast of Lake Nyasa, has an ample rainfall—April and February being the wettest months. In the higher inland areas of the Southern and Southern Highland Provinces, cold nights with occasional ground frost are likely from June to September. Highest day temperatures are in the low seventies.

Other weather data are presented in Table 4-1.

TABLE 4-1

EAST AFRICA WEATHER DATA

Place	Altitude (Ft)	Mean Temperature (°F)	Maximum Temperature (°F)	Minimum Temperature (°F)	Maximum Temperature (°F)	Minimum Temperature (°F)	Average Annual Rainfall (In.)	Mean Cloud Amount (0-8)	Mean Relative Humidity (%)
Kenya									
Eldoret	6,863	62.5	75.9	49.0	87.0	37.0	40.86	4.4	59
Equator	9,062	55.8	65.1	46.5	76.8	38.6	46.93	5.9	67
Kisumu	3,760	73.9	84.8	62.9	98.4	51.4	49.06	5.3	58
Kitale	6,300	65.6	77.5	53.7	89.5	39.5	48.43	4.7	63
Malindi	33	79.5	86.2	72.9	97.1	63.0	40.43	4.1	76
Mombasa	53	80.3	86.1	74.1	98.5	57.3	47.81	4.6	75
Nairobi	5,495	67.5	77.7	55.9	89.9	44.0	34.33	5.1	64
Nakuru	6,024	64.7	79.4	49.9	92.9	33.8	34.59	5.3	59
Nanyuki	6,389	61.1	74.6	47.7	86.6	33.3	28.09	5.7	61
Nyeri	5,900	63.1	74.8	51.5	91.0	40.0	35.85	5.4	69
Tanganyika									
Bukoba	3,753	70.1	79.5	60.7	88.3	50.0	79.37	5.7	79
Dar es Salaam	47	78.3	85.4	71.3	95.5	55.1	42.75	4.8	77
Dodoma	3,675	72.7	83.9	61.6	97.5	45.7	22.93	4.7	61
Iringa	5,380	66.3	76.0	56.5	91.4	41.8	29.57	4.3	62
Lindi	133	79.0	86.9	71.1	97.1	52.0	35.39	4.5	75
Mbeya	5,768	63.6	73.9	53.3	88.3	30.0	34.62	5.0	67
Moshi	2,668	74.1	85.5	62.7	100.2	47.5	35.08	5.2	63
Sao Hill	6,500	61.2	70.9	51.5	85.3	38.0	36.85	5.6	73
Tabora	4,151	73.3	83.9	62.6	96.2	48.0	35.01	4.7	58
Uganda									
Arua	4,200	73.6	85.5	63.7	93.0	50.0	54.99	5.2	67
Entebbe	3,878	70.8	78.2	63.4	91.0	51.7	62.44	5.8	77
Fort Portal	5,049	66.3	77.6	54.9	89.0	42.0	57.51	5.7	77
Gulu	3,650	73.7	84.7	62.8	98.2	48.7	59.08	5.5	65
Kabale	6,138	61.9	73.5	50.2	85.0	37.0	38.67	6.5	77
Kampala	4,304	71.5	79.9	63.1	95.0	56.0	46.33	6.0	74
Mbale	4,003	72.9	84.7	61.1	99.2	50.0	46.87	5.9	67
Soroti	3,697	75.5	86.5	64.4	104.2	57.0	51.52	4.7	63
Tororo	4,045	72.9	82.2	63.7	97.5	52.8	55.15	5.5	63
Zanzibar									
Chukwani	61	80.4	86.4	74.4	101.9	67.0	55.42	4.6	78

SECTION 5

TOPOGRAPHY, VEGETATION, AND CLIMATE OF TURKEY AND SYRIA

Since the political boundary between Turkey and Syria is related to the topography of this region, the climatic analysis of Turkey and Syria has been done by political boundaries. The chief topographical features of this area are shown in Figure 5-1.

5.1 TOPOGRAPHY, VEGETATION, AND CLIMATE OF TURKEY

5.1.1 Topography

Turkey, a mountainous country with an extensive central plateau, is bounded on the north by the Black Sea, on the west by the Aegean Sea, on the south by the Mediterranean Sea, Syria, and Iraq, and on the east by Iran and the USSR. To the south, beyond the Mediterranean Sea, lie the great plains and deserts of Africa and the Arabian Peninsula, and to north and east is the great Eurasian land mass. Air masses arriving over Turkey from these contrasting regions produce, especially in winter, a climate characterized by rapid and spectacular changes.

The topography of the country, ranging from coastal plains on the Black, Aegean, and Mediterranean Seas to the extremely rugged mountains of eastern Turkey, contributes to significant contrasts in weather. For example, the climate along the southern and western coasts, where Mediterranean-type climate is found, differs considerably from that along the Black Sea coast where seasonal changes in cloudiness and precipitation are less marked. In the mountains and highlands of eastern Turkey, Arctic conditions are present during the long winters. The central plateau is of great enough elevation and large enough area to eliminate many of the characteristics of migratory storms and, in some cases, to prevent the passage of such storms over the interior of the country.

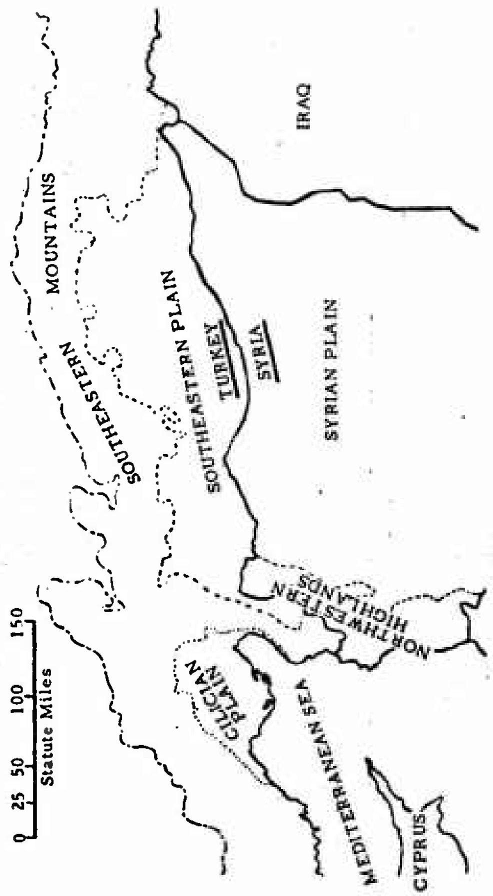


Figure 5-1 Topographic Regions of Turkey and Syria

5.1.2 Vegetation

The vegetation pattern of Turkey is illustrated in Figure 5-2.

In the Southeastern Plains, short tufted grasses and low shrubs are common. Small cultivated fields of grains and vegetables are grown near villages and in much of the plains along the Syrian border. Widely spaced deciduous oak brush about 6 ft high grows on hills and mountains in the eastern part of the region.

Cultivated areas occur in the plains and valleys in the vicinity of the Southeastern Mountains. Grain is the principal crop. Open coniferous forests grow in the western region on south-facing slopes between 1500 and 6000 ft above sea level. Most trees grow from 25 to 50 ft in height. The terrain is mostly barren above 9000 ft elevation. Grasses or brush are predominant throughout the region.

In the Cicilian Plain, thorny evergreen brush is predominant on the hills and the plains are cultivated.

5.1.3 Climate

The weather and climatic regions of Turkey are shown in Figure 5-3. In general, summers are hot and winters are cold, as is typical of mid-latitude continental areas. Temperature extremes are marked in the interior; temperatures rising to over 110°F during the summer and falling to below -45°F in winter have been recorded. Frosts are frequent at inland stations in winter, but are comparatively uncommon on the coasts. One striking characteristic of the seasons in portions of this area is that the transition from winter to summer may be very rapid, occurring within a period of a few weeks. The transition from autumn to winter is often abrupt, especially if autumn has been prolonged. There is little cloudiness during the summer except along the eastern portion of the Black Sea coast where the mean cloudiness is roughly 60%. In winter, mean cloudiness ranges from about 50% in some southern sections to nearly 80% at some Black Sea coast stations. Many overcast days occur along the northern coast in midwinter, while on the southern and western shores partly cloudy skies are not infrequent.

Except over the eastern portion of the northern coast and some elevated locations in the east, Turkey experiences dry summers, with

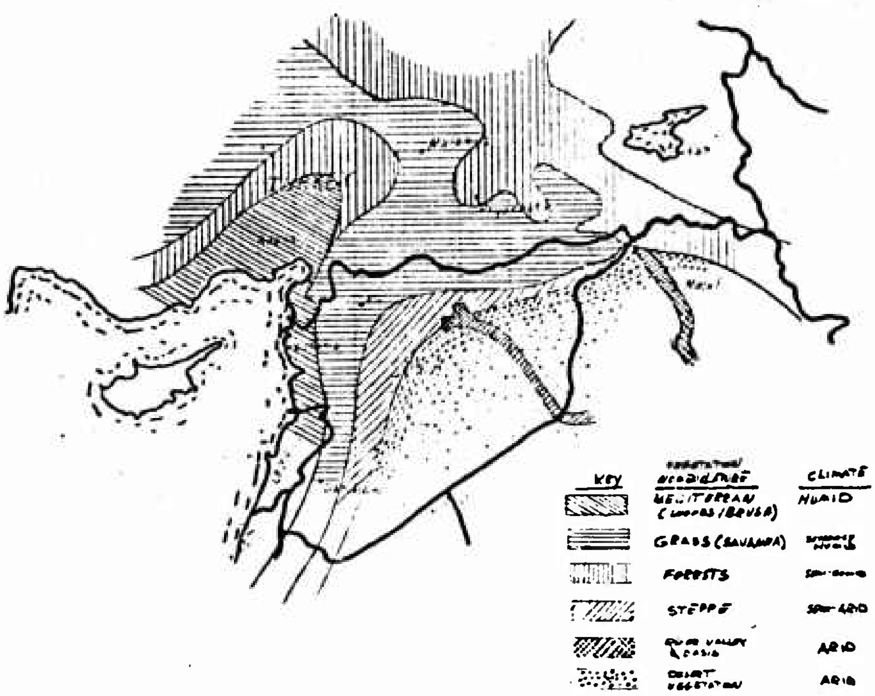


Figure 5-2 Vegetation Pattern

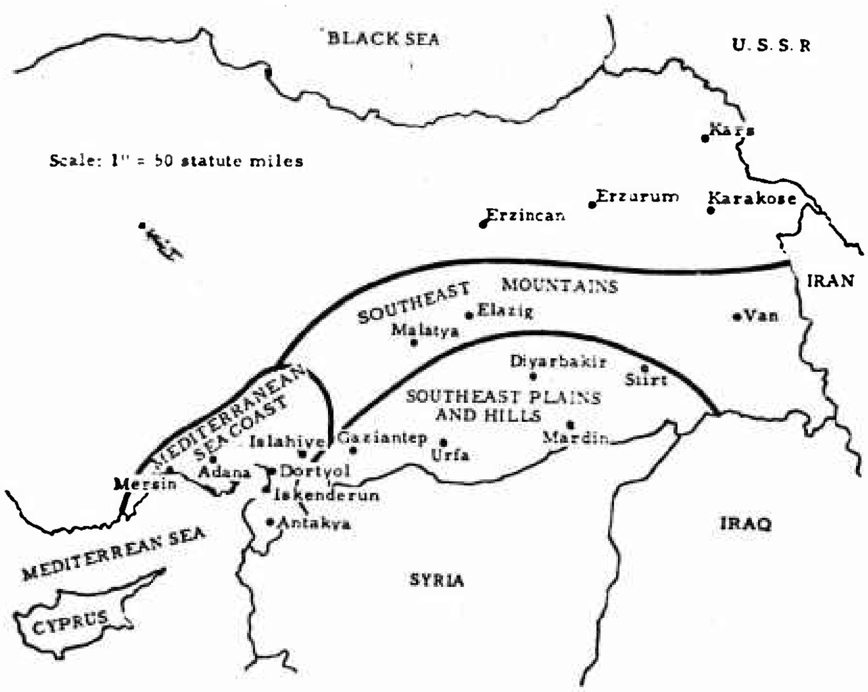


Figure 5-3 Weather and Climatic Regions – Turkey

precipitation maximums occurring in winter or spring. The amounts are quite small, however, in many localities and vary considerably from year to year. In general, precipitation amounts are greatest in the coastal sections and decrease markedly toward the interior. The greatest monthly amounts of precipitation are recorded at several stations on the northeast and southwest coasts—over 8 in. per month in December and January. In winter, precipitation falls as snow frequently in the interior and in the mountains, occasionally along the northern coast, seldom along the Aegean Sea coast, and practically never along the Mediterranean coast. The eastern mountains have many peaks which remain snowcapped the entire year.

Fog is observed more frequently in winter than during the other seasons. It is most common (2 to 7 days per month) at the interior stations and quite rare at the strictly coastal stations on the southern Aegean and Mediterranean Seas. Even during the worst months, however, visibility is generally good throughout Turkey.

The prevailing surface wind direction is from the north, although in winter winds from the south and southeast occur along the Aegean and eastern Mediterranean coasts in advance of approaching depressions. The wind direction at a particular station; however, is greatly influenced by the local topography. In addition, special winds such as boras, light siroccos, sea and land breezes, mountain and valley breezes, and etesian winds (known in Turkey as the meltemi) are observed in the area. Turbulence is common throughout Turkey. Thermal turbulence is quite well developed over the southern coastal plains and interior sections in summer and autumn. Strong drafts and gusts are experienced in the vicinity of mountains at all times of the year.

In this discussion, unless otherwise stated, the seasons are broadly defined as winter (December through March), spring (April and May), summer (June through September), and autumn (October and November).

Winter (December through March)

Numerous storms passing into the eastern Mediterranean or the Black Sea cause winter to be the cloudiest season, although there are occasional clear spells associated with outbreaks of cold air from the USSR. Overcast conditions may persist for days, more frequently in the north than in the south. With the passage of fronts, most of the coastal

mountains are enveloped in extensive clouds, especially on the seaward slopes. At such times, cloud bases at coastal stations may fall to 1000 ft above sea level; at interior stations, cloud bases are greatly influenced by the location and exposure of the station and by the intensity of the storm. Generally these interior stations are covered by layers of stratiform clouds with bases 2000 to 3000 ft above the ground; during precipitation, ceilings may lower to 800 to 1200 ft and occasionally to zero for short periods during frontal passage.

The winter cloud regime of the Mediterranean coast is much like that of the French and Italian Riviera. The coastal region averages 50% to 65% coverage with clear skies being reported 4 to 9 days per month.

The Southeast Mountains have an average cloudiness of 60% to 75%. The higher values are scattered throughout the region; the lower values are mostly on the northern slopes of the southern coastal ranges. Clear days over the northern parts of the Southeast Mountains average two to four per month in winter, increasing to three to six in the southern parts. Maximum cloudiness occurs in January or February when many stations record no more than three clear days. Cloudy days range from about eight to seventeen a month. Evening skies tend to be less cloudy than either morning or afternoon skies. Cloud heights very greatly, influenced by elevation, slope, exposure, and distance from the sea. Cloud bases are frequently 7000 to 8000 ft above sea level. Cloud tops above 20,000 ft are not uncommon. The Southeast Plains and Hills Region is, in general, the least cloudy in Turkey. Average winter cloudiness is about 55% to 65%, with January the cloudiest month. Here again, the evening hours (near 2100 LST) tend to be less cloudy than either the morning or afternoon hours (0700 and 1400 LST). Clear days average four to seven per month, while cloudy days vary from about eight to fifteen per month.

Spring (April and May)

Along the Mediterranean coast, cloudiness gradually decreases, and usually by the latter part of May the summer cloud regime is established. Cumulus activity here is well developed. In the Southeast Mountains, cumulus activity is approaching the maximum by the end of the period. Cloudiness over the Southeast Plains and Hills Region, mostly cumulus clouds, decreases throughout the season.

Summer (June through September)

Cloudiness is at a minimum throughout Turkey during this season. Over the Mediterranean coast even small amounts of clouds are infrequent, and skies are cloudless for days at a time. Cumulus activity is at a minimum but not unknown. Coastal stations along the Aegean and Mediterranean all have less than 20% cloudiness during the summer months. In the Southeast Mountains, large cumulus clouds sometimes develop in the afternoon and cause local showers. Here, summer cloudiness is more variable, ranging from less than 15% to slightly more than 45% depending on elevation and exposure. The average number of clear days ranges from five to twenty-five per month over these regions. No station in the Southeast Plains and Hills Region averages as much as 20% cloudiness during the summer months; Mardin has no month with more than 8% cloudiness or fewer than 24 clear days. Although summer cloudiness has been discussed in some detail, it should be stressed that in comparison to other mid-latitude areas the major portion of Turkey is practically cloudless during this season. For example, most of Turkey averages at least 20% less cloudiness in summer than the arid regions of southwestern United States.

Autumn (October and November)

During this season there is usually an increase in cloudiness of all types at all stations. The first depressions and associated fronts begin to bring widespread cloudiness. Bases of clouds are generally 3000 to 4000 ft along the coast and 200 to 3000 ft above the ground at interior stations. Heights of the cumulonimbus clouds which have become more frequent along the coastal regions may extend considerably above 25,000 ft.

5.1.3.1 Clouds

Turkey, for the most part, is noted for a considerable number of clear, sunny days, a condition typical of the Mediterranean area. There is, however, a pronounced variation in mean cloudiness from winter to summer over most of the area. Some stations record greater than 60% mean cloudiness in the cloudiest winter month and less than 10% in the sunniest summer month. The lowest mean annual cloudiness (30% to 40%) occurs in the Southeast Plains and Hills and along the Mediterranean Sea Coast. In southern Turkey during summer, cloudy days are rare. In general, the evening hours appear to be the least cloud, and the afternoon hours are the most cloudy. Mean cloudiness at specified hours and locations for each month is shown in Table 5-1. Monthly and annual means are given in Table 5-2.

TABLE 5-1

MEAN CLOUDINESS (%) AT SPECIFIED HOURS

REGION AND STATION*	HOUR (LST)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	YRS REC
Mediterranean Sea Coast:															
Adana	0700	58	60	55	52	46	34	36	24	22	36	49	55	44	22
	1400	58	62	58	58	54	3[illegible]	26	25	24	42	50	56	46	
	2100	50	49	44	41	36	22	21	17	13	27	37	47	34	
Antalya	0700	72	64	62	49	45	19	16	17	21	43	54	65	44	11
	1400	70	65	64	51	47	20	14	14	22	42	53	66	44	
	2100	62	50	50	3[illegible]	32	12	14	7	11	26	40	57	31	
Dortyol	0700	59	61	56	51	43	33	37	35	27	36	48	55	45	22
	1400	60	61	56	52	46	30	30	28	22	36	47	54	44	
	2100	50	52	46	45	45	40	48	40	39	33	37	46	45	
Islahiye	0700	73	59	59	47	38	41	33	12	16	37	53	66	40	13
	1400	70	67	66	65	53	28	27	19	27	46	57	68	48	
	2100	59	50	48	39	31	15	13	9	12	26	41	56	33	
Mersin	0700	63	61	62	53	50	35	36	31	24	40	57	64	43	11
	1400	63	61	62	58	58	37	24	21	27	43	56	64	49	
	2100	62	51	49	41	46	38	28	21	15	33	44	56	40	
Southeast Mountains:															
Elazig	0700	74	69	60	55	43	11	10	7	12	39	55	67	42	13
	1400	72	73	70	66	59	13	19	14	20	44	58	70	50	
	2100	62	61	55	50	41	24	14	8	12	30	43	62	39	
Malatya	0700	69	69	56	51	38	12	7	6	13	36	54	67	40	22
	1400	68	70	61	62	54	10	16	16	22	42	56	67	4[illegible]	
	2100	60	62	47	44	41	21	11	10	14	29	45	58	37	
Van	0700	67	65	61	54	47	17	15	11	12	44	50	56	42	11
	1400	65	61	61	56	54	31	25	22	20	44	51	54	45	
	2100	60	57	58	55	50	31	25	16	14	18	46	49	42	
Southeast Plains and Hills:															
Diyarbakir	0700	65	63	54	53	41	11	9	6	11	35	53	59	38	22
	1400	64	65	61	62	55	26	19	11	19	41	55	60	50	
	2100	55	54	48	45	39	17	11	4	10	29	44	50	34	
Gaziantep	0700	67	60	57	43	36	7	4	4	8	34	51	61	36	11
	1400	67	66	68	61	55	25	12	14	18	43	54	62	46	
	2100	58	49	46	36	29	9	4	3	8	24	39	51	30	
Mardin	0700	65	60	56	50	40	7	7	5	7	35	48	59	37	8
	1400	66	61	61	53	45	11	9	6	11	38	49	58	39	
	2100	61	51	49	39	33	5	6	4	6	33	39	51	31	
Siirt	0700	69	65	64	55	42	13	9	7	10	39	52	57	40	11
	1400	71	67	70	64	56	24	17	11	15	42	55	61	44	
	2100	61	51	52	44	44	13	10	5	8	28	42	52	34	
Urfa	0700	61	58	52	46	31	7	5	4	11	30	49	57	34	19
	1400	62	60	60	52	44	19	12	8	20	35	50	57	40	
	2100	52	50	42	35	26	10	5	3	9	22	40	47	29	

* Station locations are indicated in Figure 5-3

TABLE 5-2

MEAN CLOUDINESS (%)

REGION AND STATION*	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	YRS REC
Mediterranean Sea Coast:														
Adana	56	57	52	50	46	30	28	23	21	35	45	53	41	22
Antakya	68	60	53	46	41	17	13	12	19	38	49	63	41	11
Dortyol	56	58	53	50	45	35	39	37	29	35	44	52	44	22
Mersin	66	58	58	52	51	35	30	25	22	40	52	61	46	11
Southeast Mountains:														
Elâziğ	69	68	62	57	48	22	14	10	15	34	52	66	44	13
Malatya	66	67	55	54	44	22	12	11	16	36	52	64	42	22
Van	64	61	60	55	50	26	22	17	17	42	49	53	43	11
Southeast Plains and Hills:														
Diyarbakir	61	61	54	53	45	18	13	9	13	34	51	57	39	22
Gaziantep	64	58	57	47	40	13	7	7	11	34	48	58	37	11
Mardin	64	58	55	47	40	8	7	5	8	35	45	56	36	8
Siirt	67	61	62	54	45	16	13	8	11	36	49	57	40	11
Urfa	58	56	52	44	34	12	8	5	14	29	46	54	34	19

* Station locations are indicated in Figure 5-3

5.1.3.2 Visibility and Ceiling

Visibility

The frequency of surface visibilities less than 3/4, 2 1/2, and 6 mi at 0800, 1400, and 2000 LST is given in tabular form in Table 5-3. There are large variations between stations in the frequency of occurrence of low visibilities because of local factors such as the collection or drainage of cold stagnant air, type of vegetation, and exposure to moist air masses. Most Turkish stations exhibit both a seasonal and diurnal variation. The poorest visibility conditions occur in winter and the best in summer. Midday visibilities are definitely better than those of early morning or evening.

Although there are large differences in visibility from station to station within a region, some generalization is possible. It may be well, however, to examine the limitations to the data used in the discussion. First, Table 5-3, which gives the percentage frequency of visibilities in specified ranges for various times of the day, is in all probability biased toward better visibilities; i.e., it will not show the maximum frequency of low visibilities. This conclusion, especially as to spring, summer, and autumn values, is based on the widespread finding that visibilities are usually poorest very near sunrise. It is obvious that the sun would have already initiated some clearing by the 0800-0900 LST observation on all but the shortest winter days. Second, the period of record (five years) is not sufficient to disclose accurately the trends of such small percentage frequencies as are recorded. Third, Table 5-4, which shows the mean number of days with visibilities less than 0.6 mi in fog, indicates occurrence of visibilities within a rather limited range. Along the Mediterranean coast, fog is not a common phenomenon, except at some particularly sheltered locations generally removed a few miles from the sea or at elevated locations where low clouds (observed as fog) often cover the slopes and tops of mountains. During the passage of a depression along the south coast, fog may persist at the elevated locations for long periods, sometimes as long as three days. At the coastal station visibilities less than 2 1/2 mi generally occur less than 2% of the time; the annual number of days with fog varies from practically zero to 6. At stations a few miles inland, fogs may occur on as many as twelve days during the winter.

TABLE 5-3

PERCENTAGE FREQUENCY OF SPECIFIED VISIBILITY RANGES AT SPECIFIED HOURS

REGION AND STATION*	HOUR (LST)	RANGE (miles)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	YRS REC
Mediterranean Sea Coast Adana	0800	< 1/4	[illegible]	[illegible]	1.1	[illegible]	[illegible]	0.0	[illegible]	0.0	0.0	0.0	[illegible]	0.0	0.2	9
		< 2 1/2	2.1	1.1	[illegible]	[illegible]	[illegible]	0.0	[illegible]	[illegible]	0.0	0.0	0.6	0.7	0.6	
		< 6	6.1	7.1	6.7	5.4	[illegible]	4.1	10.1	2.7	0.7	1.5	2.4	7.8	6.0	
	1400	< 1/4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.0	0.0	0.1	0.8	0.0	0.0	0.7	0.1	
		< 2 1/2	2.7	[illegible]	1.7	[illegible]	[illegible]	0.0	[illegible]	[illegible]	0.7	0.0	0.0	1.4	0.5	
		< 6	10.2	[illegible]	7.4	3.1	10.2	2.2	[illegible]	0.9	0.7	0.8	2.4	10.6	4.6	
	2000	< 1/4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.0	0.9	0.0	0.0	0.1	
		< 2 1/2	4.5	2.3	1.7	0.8	[illegible]	[illegible]	[illegible]	3.1	0.0	0.0	0.0	2.1	0.8	
		< 6	12.5	13.0	6.6	10.7	5.1	[illegible]	[illegible]	0.0	2.1	0.8	4.8	14.2	6.0	
Iskenderun	0800	< 1/4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.0	0.0	0.0	0.0	0.0	9
		< 2 1/2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.0	0.0	0.0	0.0	0.0	
		< 6	2.0	[illegible]	1.1	2.7	[illegible]	0.7	[illegible]	[illegible]	0.0	0.7	2.7	2.4	1.1	
	1400	< 1/4	0.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.0	0.0	0.0	0.0	0.0	
		< 2 1/2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.0	[illegible]	[illegible]	0.0	0.0	0.0	0.0	0.0	
		< 6	2.5	2.1	[illegible]	1.4	[illegible]	0.0	[illegible]	[illegible]	0.0	0.0	2.0	6.5	1.4	
	2000	< 1/4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.0	0.0	0.0	0.0	0.0	
		< 2 1/2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.0	0.7	0.0	0.0	1.6	0.2	
		< 6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2.7	[illegible]	[illegible]	1.0	11.7	18.7	21.1	16.8	
Southeast Mountains Malatya	0900	< 1/4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.0	0.0	0.0	0.0	0.8	8.4	16.4	5.6	9
		< 2 1/2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.0	[illegible]	0.0	0.0	2.4	10.9	21.8	[illegible]	
		< 6	57.7	28.7	[illegible]	10.1	[illegible]	[illegible]	[illegible]	0.0	0.8	8.9	27.0	41.7	16.9	
	1500	< 1/4	[illegible]	[illegible]	1.7	[illegible]	[illegible]	[illegible]	[illegible]	0.0	0.0	0.0	5.1	9.9	3.5	
		< 2 1/2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.5	0.0	0.0	0.0	0.0	7.6	19.7	6.5	
		< 6	[illegible]	[illegible]	17.5	6.7	4.2	0.8	0.0	[illegible]	1.7	6.6	22.7	41.0	15.9	
	2100	< 1/4	[illegible]	7.6	1.6	[illegible]	0.0	0.0	0.0	0.0	0.9	0.0	5.0	11.6	3.7	
		< 2 1/2	27.5	18.2	7.1	[illegible]	2.4	0.0	0.0	0.0	0.0	0.8	7.5	19.9	7.0	
		< 6	[illegible]	[illegible]	61.6	[illegible]	41.9	14.2	0.8	1.2	9.2	18.0	45.1	65.7	40.2	
Southeast Plains and Hills Diyarbakir	0900	< 1/4	15.9	8.7	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.7	2.1	8.3	1.8	9
		< 2 1/2	22.0	10.3	2.1	0.9	2.1	0.8	0.0	0.0	0.8	0.7	2.8	9.9	4.2	
		< 6	31.1	22.8	11.2	[illegible]	6.2	0.0	0.0	0.0	0.8	2.7	12.5	21.2	9.6	
	1500	< 1/4	9.6	1.8	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	2.9	1.5	
		< 2 1/2	14.0	6.1	2.7	0.9	0.0	0.0	0.0	0.0	0.0	0.0	2.8	5.1	2.6	
		< 6	[illegible]	15.3	11.5	9.8	4.1	0.7	0.0	0.0	0.0	1.4	8.4	15.4	7.7	
	2100	< 1/4	9.5	[illegible]	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	5.6	1.9	
		< 2 1/2	11.2	5.1	1.4	0.9	1.4	0.0	0.0	0.0	0.7	0.0	2.8	7.7	2.7	
		< 6	26.6	19.8	12.1	9.7	2.8	0.0	0.0	0.7	2.1	2.0	9.0	16.7	6.6	

*Station locations are indicated in Figure 5-3

TABLE 5-4

MEAN NUMBER OF DAYS WITH FOG (VISIBILITY < 0.6 MILE)

REGION AND STATION**	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	YRS REC
Mediterranean Sea Coast:														
Adana	0.3	0.6	1.0	1.5	0.9	0.4	0.4	0.3	0.1	0.0	0.2	0.2	6.0	22
Antakya	1.5	0.6	0.4	0.1	*	0.0	0.0	0.0	*	0.4	1.5	1.5	5.9	11
Islâhiye	0.3	0.9	*	0.0	0.1	0.0	0.0	0.0	0.1	0.1	0.1	0.4	1.9	15
Mersin	0.1	0.1	0.5	0.6	0.5	0.1	0.1	*	0.0	0.4	0.4	0.1	2.8	17
Southeast Mountains:														
Elâziğ	3.2	2.8	1.9	0.8	0.7	0.3	0.5	0.2	0.1	0.3	1.9	3.8	16.7	19
Malatya	2.6	2.4	0.8	0.2	*	*	0.0	*	0.1	0.4	1.2	3.0	10.7	22
Van	0.3	0.5	1.4	0.9	0.9	0.1	*	*	*	*	0.4	0.8	5.1	17
Southeast Plains and Hills:														
Diyarbakir	3.3	2.2	0.6	0.3	0.4	*	0.0	0.0	*	0.6	0.8	3.5	11.6	22
Gaziantep	2.9	1.0	0.4	*	0.0	0.0	0.0	0.0	*	0.1	0.6	1.4	6.4	14
Mardin	7.6	4.9	4.2	2.1	0.6	*	0.0	0.0	*	0.2	2.7	4.5	26.7	12
Siirt	3.2	1.1	0.8	0.1	0.2	*	0.0	*	0.1	0.1	0.6	1.6	7.7	19
Urfa	1.7	0.7	0.7	0.3	0.3	0.1	0.0	0.2	0.1	0.6	1.3	1.4	7.2	19

* < 0.05 inch

** Station locations are indicated in Figure 5-3

At the interior stations, fog (visibility - 0.6 mi) occurs on about one to seven days per month during the winter; the annual total varies from five to forty days depending on location. At stations located in a basin where the air, cooled at night by radiation, has little chance to drain away, visibilities are reduced to 2 1/2 mi on as many as one-third of the days in January and February. The fog usually disperses by noon but may reform early in the afternoon. It may even persist all day, especially when the ground is covered with snow.

Fog may occur in any month but the frequency is small indeed during the summer. Over the Mediterranean Sea Coast Region, some locations removed by a few miles from the sea have an occasional summer morning fog, but in general, fogs are almost negligible in the region. A few locations in the interior report early morning fogs, which invariably dissipate quickly in the morning, so that before midday the visibility is usually unlimited except on mountain slopes which are enveloped by clouds.

Snow often reduces visibility during the winter. In general, light snow reduces surface visibility to between 2 and 5 mi, moderate snow to between 1 and 2 mi, and heavy snow to less than 1 mi. Air-ground visibilities are reduced to much lower values by the same snow intensities. Heavy snows reducing visibility to less than 1/2 mi occur in the Southeast Mountains Region. All regions of the area except the southern part of the Mediterranean Sea Coast Region experience snow and snowshowers during the winter, the frequency increasing from south to north and from west to east.

Haze, which is observed in all seasons but predominantly in summer and autumn, may also reduce visibilities over large areas and for long periods of time. The stable air of the etesian drift may arrive over Turkey laden with smoke and dust, and, although surface visibilities are not greatly reduced, the air-ground visibility may be restricted to 3 to 5 mi for as long as 10 days at a time.

Ceiling

As might be expected from the discussion on cloudiness, the maximum frequency of low cloudiness and ceilings (cloudiness equal to or greater than 0.6) occurs in winter and the minimum frequency in summer. During winter, ceilings below 1000 ft are rather infrequent at most locations. At altitudes above 1000 ft, the frequency of occurrence of

ceilings is much greater. During the worst winter months, ceiling less than 3000 ft occur more than 40% of the time at most stations, except those located along the southern coasts.

During the summer, cloud conditions would have little effect on most low-level operations. In the interior, even when ceilings are present, they are generally above 5000 ft; along the Mediterranean coast where the requirement for flight altitude is not so great, ceilings are generally not below 3000 ft. The diurnal variation is, however, reversed in summer with the afternoon hours being those of maximum ceiling frequency. Table 5-6 shows the frequency of ceilings at specified altitudes for one morning observation per day.

Combined Ceilings and Visibilities

Mention has been made of the frequency of occurrence and the areal distribution of both low visibilities and ceilings as they separately affect low-level aircraft operation. It is obvious that either or both may affect a particular operation and that they are not entirely independent, so that the probability of occurrence of both is not simply the product of the sum of the probabilites of either. It is, therefore, useful to examine their frequencies of occurrence from an "and/or" point of view.

Summer is the season of least restricted terminal flying conditions and winter, the season of most restricted conditions. In general, ceilings and visibilities in the early morning hours are lower than those of either the afternoon or evening hours, although at some mountain locations this is not necessarily true. Frequencies vary widely from one location to another in the Southeast Mountains Region where some of the worst terminal flying conditions in Turkey may occur. Along the Mediterranean coast, low ceilings and visibilities are rare. At Iskenderun, for example, ceilings are equal to or greater than 1000 ft and visibilities are 3 mi or better nearly 100% of the time.

5.1.3.3 Surface Winds

In Turkey, the complex surface configuration is an important control on surface wind direction and speed. The surface winds are frequently obstructed or diverted by mountains, valleys, and coastal configurations. The mean surface airflow patterns indicate that in summer the prevailing wind direction over Turkey is from the north to northeast.

TABLE 5-5

PERCENTAGE FREQUENCY OF SPECIFIED CEILING* HEIGHT AT SPECIFIED HOURS

REGION AND STATIONS**	HOUR (LST)	HEIGHT feet	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	YRS REC
Mediterranean Sea Coast: Adana	0900	<500	0.0	0.0	[illegible]	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	5
		<1,000	0.7	[illegible]	0.7	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	
		<2,000	2.8	0.9	1.4	0.8	0.7	0.0	0.0	0.0	0.0	0.0	0.8	0.7	0.4	
		<5,000	10.5	[illegible]	3.4	6.6	11.1	5.6	5.4	1.4	0.7	2.4	2.4	5.0	5.5	
Iskenderun	0900	<500	0.0	0.0	[illegible]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5
		<1,000	0.0	0.0	[illegible]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		<2,000	6.5	6.1	[illegible]	3.7	0.0	0.0	0.0	0.0	0.0	0.0	1.1	4.9	2.1	
		<5,000	21.5	25.0	[illegible]	12.1	8.1	12.1	16.1	19.4	6.7	7.8	14.0	16.5	14.5	
Southeast Mountains: Malatya	0900	<500	1.1	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	8.2	1.5	5
		<1,000	7.7	1.7	[illegible]	0.8	0.0	0.0	0.0	0.0	0.0	0.8	1.4	12.4	2.5	
		<2,000	17.0	15.5	[illegible]	[illegible]	[illegible]	1.7	0.0	0.0	0.0	4.1	11.0	29.4	12.1	
		<5,000	54.2	41.1	[illegible]	[illegible]	12.1	[illegible]	1.0	0.0	0.8	12.2	29.6	52.0	29.6	
Southeast Plains and Hills: Diyarbakir	0900	<500	10.6	1.9	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	4.4	1.7	5
		<1,000	15.1	7.0	5.1	1.8	1.4	0.0	0.0	0.0	0.0	0.0	2.8	[illegible]	3.3	
		<2,000	29.5	16.1	[illegible]	[illegible]	[illegible]	0.0	0.0	0.0	0.0	1.5	9.7	12.1	7.1	
		<5,000	37.1	29.7	[illegible]	14.9	[illegible]	0.7	0.0	0.0	0.0	4.0	14.2	21.4	[illegible]	

* Ceiling herein is defined as ≥ 5 6-tenths cloud cover

** Station locations are indicated in Figure 5-3

In winter, the mean airflow pattern is less definite and the wind direction is subject more to the influence of passing depressions, with strong southerly flow preceding the depression and strong northerly winds following.

Wind data for the interior and protected coasts show a high percentage of calms or light wind speeds. As a result, mean surface wind speeds are low, 95% to 99% of all winds are less than 19 mph with calm to 3 mph being the predominant speed at many stations. Wind speeds over 31 mph occur less than 1% of the time. The percentage frequency of specified mean wind speeds at various stations is shown in Table 5-6.

Along the Mediterranean coast, winds are generally from a northerly direction. At Adana winds are light and generally from a northerly direction, while at Iskenderun, a few miles away, they are light and from a southerly direction. Local topography has reversed the prevailing wind direction.

In the interior, winds are extremely variable and generally light during winter. Winds may be channeled at stations lying in valley bottoms, so that there is a tendency for contrasting winds.

During the transition period from winter to summer many changes occur in wind directions at various stations. At interior stations particularly, stronger winds begin to occur and the percentage of calms decreases.

In summer, northerly flow is predominant over Turkey, but surface winds are variable because of topography. Summer is the season of fewest calms in the interior and most calms at coastal stations.

Winds during autumn are similar to those of the spring transition season. Maximum wind speeds vary greatly within the region and are subject more to local influences than to regional climatic controls.

5.1.3.4 Precipitation

General

Most of the winter precipitation in Turkey occurs during the passage of frontal systems and is generally widespread and continuous. In spring, showery precipitation invades the interior regions, falling

TABLE 5-6

PERCENTAGE FREQUENCY OF SPECIFIED MEAN WIND SPEEDS

REGION AND STATION*	MEAN SPEED** (mph)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	YRS REC
Mediterranean Sea Coast															
Adana	0-3	64.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	72.3	67.2	5
	4-10	29.3	[illegible]	[illegible]	31.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	25.7	19.1	27.5	[illegible]	
	19-31	1.3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2.9	[illegible]	[illegible]	[illegible]	0.2	[illegible]	
	≥ 32	0.3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.0	0.0	0.0	1.2	
Iskenderun	0-3	73.6	[illegible]	[illegible]	[illegible]	62.4	[illegible]	[illegible]	64.2	[illegible]	[illegible]	81.7	72.3	[illegible]	[illegible]
	4-10	26.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	17.8	[illegible]	[illegible]	
	19-31	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.0	[illegible]	[illegible]	[illegible]	
	≥ 32	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.0	0.0	[illegible]	[illegible]	
Southeast Mountains															
Malatya	0-3	[illegible]	84.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	82.7	[illegible]	[illegible]	4
	4-10	[illegible]	15.3	[illegible]	37.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	17.0	[illegible]	[illegible]	
	19-31	0.3	0.0	1.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.0	0.3	[illegible]	[illegible]	
	≥ 32	[illegible]	0.0	[illegible]	[illegible]	0.6	[illegible]	[illegible]	0.0	0.0	0.0	0.0	[illegible]	[illegible]	
Southeast Plains and Hills															
Diyarbakir	0-3	60.7	43.0	33.3	[illegible]	[illegible]	21.6	[illegible]	24.4	34.5	51.1	63.3	[illegible]	41.4	5
	4-10	37.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	77.7	72.1	[illegible]	47.1	35.8	[illegible]	[illegible]	
	19-31	1.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.8	0.7	[illegible]	3.0	
	≥ 32	[illegible]	[illegible]	[illegible]	0.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.0	0.2	[illegible]	0.2	

*Station locations are indicated in Figure 5-3

** Mean wind speed is average of 0800, 1400, and 2000 LST wind speeds

from the cumulus clouds prevalent in that season. Summers are almost without rainfall over all the interior regions except at locations in the Southeast Mountains Region. In the Southeast Mountains Region showers are frequent. Autumn is similar to spring with frontal precipitation common. Mean monthly precipitation amounts are presented in Table 5-7.

In most of Turkey, as in other areas where there is a pronounced dry and wet season or where annual rainfalls are not large, total rainfall amounts vary considerably from year to year. At most stations located in the interior, precipitation occurring in a particular year has exceeded or fallen below the mean annual amount by more than 50%, and at some stations it has exceeded the mean annual amount by almost 100%. Dry months (total precipitation less than 1 in.) have occurred at all locations in Turkey and are not necessarily restricted to the dry season. Absolutely dry months (no measurable precipitation) have occurred in all sections. Very wet months (precipitation greater than 10 in.) usually occur during the rainy season along coastal regions. Data on absolute maximum and minimum precipitation are given in Table 5-8. These data should be used with caution since most stations have only short periods of record.

Compared with many midlatitude areas, the maximum 24-hr precipitation amounts for Turkish stations are not large. The greatest amounts are mostly confined to the coastal areas, where the maximums of record change from about 4 to 8 in. in 24 hr at most stations. In the interior, maximum recorded 24-hr falls are generally 1.5 to 3.5 in. During any one year, 24-hr falls over the interior of more than 1 in. are uncommon, and falls of more than 2 in. are exceptional. In any region, the maximum 24-hr amount may occur in any season and, indeed, seems to be equally as likely during the dry season as in any other, except perhaps in the Southeast Plains and Hills Region. The rare summer cloud burst in many sections may be the heaviest rainfall of the decade.

Regional

In the Mediterranean Sea Coast Region is found the typically Mediterranean-type precipitation regime. In winter, rainfall is abundant, while summers are virtually rainless. Most of the stations have a total of 1 to 3 in. of rain during the four summer months. Average annual precipitation over the region ranges from about 24 to 48 in.

TABLE 5-7

MEAN PRECIPITATION (INCHES)

REGION AND STATIONS**	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	YRS REC
Mediterranean Sea Coast														
Adana	3.9	4.2	2.4	1.6	2.0	0.6	0.2	0.2	0.7	1.4	2.5	3.6	24.4	22
Antalya	10.2	[illegible]	[illegible]	4.1	2.0	1.4	0.1	0.7	1.0	4.4	9.0	6.6	45.4	11
Dortyol	4.2	[illegible]	4.4	1.3	2.4	2.1	1.2	1.4	2.7	4.3	3.3	4.6	42.6	22
Iskenderun	7.8	[illegible]	4.1	2.2	1.5	[illegible]	[illegible]	0.2	[illegible]	2.5	4.1	5.5	35.2	16
Mersin	4.2	4.3	[illegible]	1.4	1.0	0.5	[illegible]	0.2	0.5	2.0	3.3	4.4	24.2	21
Southeast Mountains														
Elazig	1.7	[illegible]	[illegible]	2.7	[illegible]	0.6	0.1	0.1	0.2	1.7	2.5	1.8	17.3	21
Malatya	1.8	1.4	1.7	2.1	1.4	0.5	0.2	0.1	[illegible]	1.1	1.6	1.4	16.3	22
Van	[illegible]	1.4	[illegible]	2.2	1.6	[illegible]	0.2	0.1	[illegible]	1.8	[illegible]	1.1	15.0	20
Southeast Plains and Hills														
Diyarbakir	3.0	2.7	2.1	2.7	1.6	0.2	*	*	0.1	1.2	2.2	2.5	18.5	22
Gaziantep	4.7	3.6	2.7	2.1	0.8	0.1	*	0.1	0.2	1.6	2.5	4.0	23.0	17
Mardin	5.1	5.4	[illegible]	[illegible]	[illegible]	[illegible]	*	*	*	1.1	3.5	4.5	27.2	12
Siirt	4.5	3.7	[illegible]	[illegible]	2.4	[illegible]	0.1	*	0.1	1.6	3.7	3.7	27.6	21
Urfa	4.2	3.6	[illegible]	[illegible]	1.7	[illegible]	*	*	*	0.8	1.7	3.0	17.5	19

* < 0.04 inch

** Station locations are indicated in Figure 5-3

TABLE 5-8

GREATEST AND LEAST MONTHLY AND ANNUAL PRECIPITATION (INCHES)

REGION AND STATIONS*		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	YRS REC
Mediterranean Sea Coast															
Adana	Greatest	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	8.7	[illegible]	12
	Least	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
Dortyol	Greatest	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Least	[illegible]	2.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	26.4	
Southeast Mountains															
Elazig	Greatest	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	17
	Least	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
Malatya	Greatest	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6
	Least	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
Southeast Plains and Hills															
Diyarbakir	Greatest	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	12
	Least	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
Urfa	Greatest	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Least	1.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	

[illegible]

* Station locations are indicated in Figure 5-3

Data indicate that precipitation in the Southeast Mountains Region is light. Spring is the season of maximum precipitation, although the variation between seasons is less than in some other sections.

The Southeast Plains and Hills Region has somewhat more precipitation than the Southeast Mountains, with annual averages ranging from about 17 to 28 in. There is essentially no rain in the summer; everywhere the total is less than 1 in. during the four summer months. In winter, precipitation occurs on about 10 to 14 days per month, mostly in the form of rain but sometimes in the form of sleet.

Snow and Snow Cover

Snow and snow cover in Turkey are widely variable. The mean number of days with snowfall ranges from zero at some stations along the Mediterranean Coast to more than 60 annually in the eastern mountains (Table 5-9). The mean number of days with snow cover ranges from zero at some stations along the Mediterranean Coast to 120 days at elevated stations in the eastern mountains (Table 5-10). Since the number of days with snow cover and the depth of snow are greatly dependent on topographical features, exposure, and elevation, this discussion serves only to indicate some expected conditions; the data are representative only of the immediate vicinity of the site of the observation.

On the Mediterranean coast, snow is very rare at sea-level stations. Even stations located some distance inland have less than 10 days per year with snow. In the Anti-Taurus Mountains, snow may fall at any time between September and May and may remain on the ground for long periods. Snow may remain throughout the year at the higher elevations on shady northern slopes and in places where snow has drifted or avalanched to great depth. The highest passes may be blocked from late autumn to early spring, but below 10,000 ft temporary thaws occur.

In the Southeast Mountains Region, snowfall and snow cover vary considerably from station to station. In general, the lower elevations have the least snow. At the lower elevations, snowfalls are comparatively light but during exceptional winters heavy snowfalls occasionally occur. At Malatya during the winter of 1953-1954, a 40-in. accumulation of wet snow caused the collapse of a number of quonset-type structures. At elevated locations where snow falls on 50 to 60 days per year, accumulations may

TABLE 5-9

MEAN NUMBER OF DAYS WITH SNOWFALL

REGION AND STATION*	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	YRS REC
Mediterranean Sea Coast														
Adana	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Antakya	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Dörtyol	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Iskenderun	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Mersin	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Eastern Mountains														
Elazig	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Erzincan	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Erzurum	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Karakose	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Kars	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Malatya	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Van	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Southeast Plains and Hills														
Diyarbakir	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Gaziantep	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Mardin	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Siirt	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Urfa	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

* Station locations are indicated in Figure 5-3

TABLE 5-10

MEAN NUMBER OF DAYS WITH SNOW ON GROUND AT 0700 LST

REGION AND STATION*	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	YRS REC
Mediterranean Sea Coast														
Adana	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Antakya	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Dörtyol	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Iskenderun	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Mersin	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Eastern Mountains														
Elazig	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Erzincan	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Erzurum	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Karakose	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Kars	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Malatya	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Van	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Southeast Plains and Hills														
Diyarbakir	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Gaziantep	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Mardin	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Siirt	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Urfa	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

* Station locations are indicated in Figure 5-3

be great and remain on the ground for 4 to 5 months. Above 4500 ft the ground is usually covered with snow from December through March, except in the vicinity of Lake Van, which exerts a profound moderating influence on the climate of the surrounding section.

5.1.3.5 Temperature

Temperatures vary considerably from one region to another and to a lesser extent from station to station within a region. The most pronounced variability is found in the absolute minimum temperatures. The range of absolute maximum temperatures is not nearly so great; in all regions there are stations which have absolute maximum temperatures of more than 100°F. Tabular data on temperatures for a number of stations are presented in Table 5-11.

Daily temperature ranges are greatest during the summer and in the interior, especially at those places in the interior situated in basins or flat valleys. Cold air drainage from surrounding mountains and plateaus is trapped in the basin and nocturnal radiation is almost unrestricted because of clear skies. A range of 60°F between the maximum and minimum temperatures of the same day has been recorded at an interior station surrounded by high mountains.

Mediterranean Sea Coast

Along the Mediterranean coast, mean maximum temperatures are generally in the upper 50s and mean minimums in the lower 40s, with inland values 5° to 10°F lower. The annual frequency of frost days increases with greater distance from the ocean and with increasing elevation, varying from about 2 days to more than 30.

Summers are extremely hot and sultry throughout the Mediterranean Coast Region, especially in the lowlands. Human efficiencies are very low. Even at night there is little relief from the heat. During July and August, the warmest months, mean maximum temperatures range from 85° to almost 100°F at most stations. Temperatures at coastal fringe stations are mitigated somewhat by sea breezes. An example of this is found on the Cilician Plain where Mersin, located immediately on the coast and exposed to the sea breeze, has a mean daily maximum temperature a full 7°F cooler than that of Adana, located about 20 miles inland.

TABLE 5-11

MEAN DAILY MAXIMUM AND MINIMUM TEMPERATURES (°F.)

REGION AND STATION*		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	YRS REC
Mediterranean Sea Coast															
Adana	Max	57	[illegible]	[illegible]	71	82	[illegible]	[illegible]	94	91	84	75	61	77	22
	Min	[illegible]	41	[illegible]	52	59	[illegible]	71	72	[illegible]	56	51	41	55	22
Antalya	Max	52	[illegible]	[illegible]	72	[illegible]	84	[illegible]	[illegible]	87	80	69	[illegible]	72	11
	Min	39	42	[illegible]	[illegible]	[illegible]	70	74	[illegible]	70	56	50	45	57	11
Dortyol	Max	59	61	[illegible]	72	81	[illegible]	[illegible]	[illegible]	[illegible]	82	71	61	76	22
	Min	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	75	72	64	[illegible]	48	60	22
[illegible]	Max	[illegible]	51	57	[illegible]	[illegible]	87	[illegible]	[illegible]	87	76	[illegible]	52	72	11
	Min	[illegible]	[illegible]	41	[illegible]	[illegible]	[illegible]	71	71	[illegible]	55	47	39	51	11
Mersin	Max	[illegible]	55	[illegible]	71	[illegible]	82	[illegible]	[illegible]	[illegible]	78	71	61	72	11
	Min	42	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	74	[illegible]	[illegible]	[illegible]	46	57	11
Southeastern Mountains															
[illegible]	Max	[illegible]	[illegible]	43	[illegible]	71	84	92	92	84	[illegible]	55	42	65	11
	Min	[illegible]	25	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	44	39	29	46	14
Malatya	Max	[illegible]	39	[illegible]	[illegible]	75	84	91	92	[illegible]	70	55	41	65	22
	Min	[illegible]	[illegible]	[illegible]	44	[illegible]	60	[illegible]	[illegible]	58	49	37	29	46	22
Van	Max	[illegible]	35	41	51	[illegible]	76	84	85	76	[illegible]	53	39	59	11
	Min	17	17	21	[illegible]	44	50	57	57	49	41	[illegible]	22	37	11
Southeast Plains and Hills															
Diyarbakir	Max	[illegible]	47	57	[illegible]	83	90	100	100	91	77	61	48	72	22
	Min	27	29	[illegible]	[illegible]	58	59	70	69	59	48	40	[illegible]	46	22
Gaziantep	Max	[illegible]	[illegible]	56	[illegible]	77	[illegible]	91	91	86	71	62	48	69	11
	Min	29	32	[illegible]	44	[illegible]	62	69	68	59	47	40	[illegible]	47	11
Mardin	Max	41	44	51	[illegible]	75	87	95	96	[illegible]	72	61	47	68	8
	Min	32	34	39	[illegible]	[illegible]	69	76	76	70	57	49	38	55	8
Siirt	Max	41	45	[illegible]	[illegible]	76	89	[illegible]	97	89	[illegible]	60	46	70	11
	Min	27	31	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	72	[illegible]	54	44	34	51	11
Urfa	Max	49	52	60	72	84	91	101	101	[illegible]	81	67	54	75	19
	Min	[illegible]	[illegible]	39	[illegible]	[illegible]	[illegible]	71	71	[illegible]	[illegible]	47	38	[illegible]	19

*Station locations are indicated in Figure 5-3

Southern Mountains

Winter temperatures in this region are quite cold. As might be expected when one considers the rugged terrain, temperatures vary widely from one location to another. During the coldest month, mean minimum temperatures are usually between zero and 25°F and afternoon temperatures between 20° and 35°F. Thawing conditions lasting several days during the winter months are rare and occur only during abnormally warm winters.

Summers are warm by day and cool by night. Temperatures are usually between 50° and 70°F in the early morning, rising to a high of 80° to 95°F during the afternoon. At higher stations, frosts are recorded at times.

Both transition seasons are very short; spring usually occurs in April and May but may extend into June. Autumn generally occurs in October. Night frosts are frequent during both seasons.

Southeast Plains and Hills

Winters in this region are not as cold as those at either the Central Plateau or Eastern Mountains. Morning temperatures below freezing are frequent, but even in winter, afternoons are often warm with temperatures occasionally exceeding 60°F. Mean minimum temperatures during the coldest month range from a few degrees below freezing to a degree above; mean maximum temperatures lie between 40° and 50°F. Temperatures as low as -11°F have been recorded at Diyarbakir, but at Mardin the lowest recorded temperature is only 10°F. Absolute maximum temperatures range between 55° and 65°F during the coldest month.

Summers are extremely hot, the hottest in the area in most respects. Mean daily maximum temperatures at Diyarbakir and Urfa during July and August are 100° and 101°F, respectively, with 70% of the days having temperatures between 100° and 115°F. The annual extreme maximums at all stations are 106° to 115°F. Even early morning temperatures during these months are relatively warm, averaging 70° to 75°F.

5.1.3.6 Relative Humidity

In spite of the fact that Turkey is known as a dry country, high relative humidities prevail during the winter. Along the coasts the seasonal variation seldom exceeds 20% but inland the range is considerably greater. For example, at Diyarbakir, the mean relative humidity during the driest month is 25%, and during the most humid months, 77%, a range of 52%. Mean relative humidities are given in Table 5-12.

The diurnal variation of relative humidity also depends upon the continentality of the station. In the interior, the diurnal range is large, especially in summer, with morning relative humidities high and afternoon humidities low. At coastal stations, the diurnal range is considerably less. Mean relative humidities at specified hours are shown in Table 5-13.

5.1.3.7 Thunderstorms and Turbulence

The number of thunderstorm days is not great anywhere in Turkey—fewer than in Arizona and New Mexico. All regions experience thunderstorms but there is a considerable range of frequencies, depending upon local topographical features. The data tabulated in Table 5-14 are thunderstorm days. By international agreement, a thunderstorm day is defined as a day on which thunder is heard. The data give no information on either the frequency of occurrence of individual thunderstorms or on the intensity and duration. The requirement that thunder should actually be heard limits the area covered by each observing point to a circle with a radius of about 12 mi.

The Mediterranean coast has a definite minimum of storms during the warmest months; the number annually ranges from 14 to 29 but averages about 21. Stations in the Southeast Mountains have a pronounced maximum of thunderstorm days during May and June, with practically none during the winter months. The average number annually is about 17. Little can be said about thunderstorm days in the Southeast Plains and Hills Region, except that there appears to be considerable range of frequencies over the region. They range from 2 annually at Mardin to 18 at Diyarbakir for the period of record.

Turbulence in the lower levels is found in all seasons and in all sections of Turkey. Orographic turbulence, produced by winds being diverted by mountains and cliffs, is common throughout the year and is

TABLE 5-12

MEAN RELATIVE HUMIDITY (%)

REGION AND STATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	YRS REC
Mediterranean Sea Coast:														
Adana	65	66	[illegible]	67	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	59	61	65	64	22
Antakya	77	71	70	[illegible]	[illegible]	67	[illegible]	67	65	66	70	78	70	11
Dortyol	60	61	59	61	61	[illegible]	[illegible]	[illegible]	[illegible]	54	54	59	60	22
Islahiye	76	72	66	60	[illegible]	51	51	51	[illegible]	54	65	74	60	13
Mersin	72	72	69	70	72	[illegible]	[illegible]	71	67	66	69	70	70	[illegible]
Southeast Mountains:														
Elazig	80	78	69	57	46	[illegible]	30	[illegible]	[illegible]	55	72	80	55	11
Malatya	78	75	62	52	47	[illegible]	31	[illegible]	[illegible]	55	71	79	54	19
Van	75	75	72	67	53	41	[illegible]	[illegible]	[illegible]	61	69	70	61	11
Southeast Plains and Hills:														
Diyarbakir	77	74	66	61	55	34	26	25	29	48	67	77	54	19
Gaziantep	79	75	70	61	[illegible]	42	[illegible]	41	[illegible]	59	70	78	59	11
Mardin	80	71	67	59	47	32	30	[illegible]	[illegible]	50	60	69	53	8
Siirt	81	75	70	61	54	39	35	35	39	53	68	76	57	13
Urfa	71	67	60	54	42	30	27	31	35	44	58	68	49	19

* Station locations are indicated in Figure 5-3

TABLE 5-13

MEAN RELATIVE HUMIDITY (%) AT SPECIFIED HOURS

REGION AND STATION*	HOUR (LST)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	YRS REC
Mediterranean Sea Coast:															
Adana	0700	74	[illegible]	72	77	75	75	77	77	71	70	72	74	74	22
	1400	[illegible]	51	47	49	45	45	[illegible]	46	[illegible]	47	51	50	45	
	2100	71	72	72	77	74	77	77	77	72	[illegible]	70	72	74	
Antakya	0700	[illegible]	[illegible]	82	79	75	77	71	71	74	80	81	86	78	11
	1400	[illegible]	[illegible]	65	60	51	55	56	56	60	46	52	64	55	
	2100	[illegible]	77	74	71	71	[illegible]	76	75	71	72	76	82	75	
Dörtyol	0700	[illegible]	65	61	[illegible]	63	64	66	68	59	57	56	61	61	22
	1400	55	52	[illegible]	52	52	54	57	55	47	45	47	52	51	
	2100	62	65	61	67	[illegible]	72	[illegible]	74	63	55	57	61	65	
İskenderun	0700	42	[illegible]	[illegible]	72	[illegible]	[illegible]	66	[illegible]	62	68	75	81	70	11
	1400	[illegible]	[illegible]	55	47	52	47	56	54	52	[illegible]	52	65	48	
	2100	77	71	65	62	57	57	61	[illegible]	58	56	67	77	64	
Mersin	0700	[illegible]	76	74	71	71	72	[illegible]	72	67	70	74	76	74	11
	1400	62	61	61	63	67	[illegible]	[illegible]	68	62	58	[illegible]	[illegible]	61	
	2100	76	[illegible]	72	75	74	[illegible]	77	[illegible]	71	70	71	75	75	
Southeast Mountains:															
Elâzığ	0700	84	84	[illegible]	[illegible]	54	41	[illegible]	[illegible]	[illegible]	66	75	86	64	[illegible]
	1400	75	71	66	[illegible]	31	23	21	24	27	41	62	71	45	
	2100	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	41	26	27	32	56	71	81	[illegible]	
Malatya	0700	82	[illegible]	71	[illegible]	57	[illegible]	[illegible]	[illegible]	45	65	[illegible]	84	61	[illegible]
	1400	74	[illegible]	51	41	35	29	22	22	25	32	[illegible]	72	45	
	2100	[illegible]	[illegible]	61	53	48	[illegible]	[illegible]	28	33	55	71	81	55	
Van	0700	75	[illegible]	77	71	[illegible]	61	[illegible]	53	52	72	77	75	68	11
	1400	67	[illegible]	61	[illegible]	47	41	[illegible]	44	[illegible]	45	56	67	52	
	2100	76	[illegible]	[illegible]	[illegible]	61	45	45	41	44	65	71	74	61	
Southern Plains and Hills:															
Diyarbakır	0700	[illegible]	84	[illegible]	[illegible]	64	[illegible]	34	35	[illegible]	[illegible]	[illegible]	84	64	[illegible]
	1400	68	[illegible]	64	41	[illegible]	21	19	19	21	35	51	61	40	
	2100	[illegible]	[illegible]	[illegible]	64	54	[illegible]	25	21	[illegible]	[illegible]	[illegible]	81	54	
Gaziantep	0700	82	82	[illegible]	72	61	[illegible]	44	[illegible]	59	72	81	85	64	11
	1400	71	[illegible]	54	44	35	[illegible]	25	26	[illegible]	41	51	66	45	
	2100	[illegible]	[illegible]	75	67	[illegible]	[illegible]	[illegible]	49	51	64	76	83	65	
Mardin	0700	76	72	71	[illegible]	51	32	35	41	43	44	64	71	[illegible]	9
	1400	[illegible]	[illegible]	[illegible]	[illegible]	41	25	23	25	[illegible]	45	55	76	[illegible]	
	2100	[illegible]	71	65	[illegible]	46	[illegible]	27	[illegible]	34	51	61	70	51	
Siirt	0700	82	[illegible]	74	[illegible]	62	47	52	41	46	[illegible]	71	74	61	11
	1400	77	[illegible]	65	51	45	41	[illegible]	[illegible]	41	46	62	71	51	
	2100	82	[illegible]	[illegible]	62	55	[illegible]	34	45	[illegible]	51	70	78	59	
Urfa	0700	77	[illegible]	71	65	[illegible]	[illegible]	35	41	44	54	67	75	59	[illegible]
	1400	[illegible]	[illegible]	47	[illegible]	[illegible]	21	19	22	26	44	46	58	[illegible]	
	2100	74	[illegible]	[illegible]	[illegible]	45	41	[illegible]	32	35	45	71	72	61	

* Station locations are indicated in Figure 5-3

TABLE 5-14

MEAN NUMBER OF THUNDERSTORM DAYS

REGION AND STATION*	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	YRS REC
Mediterranean Sea Coast:														
Adana	2	2	2	4	4	2	1	1	2	4	2	1	27	10
Antakya	1	[illegible]	4	2	3	1	0	[illegible]	1	4	3	2	26	10
Dörtyol	1	1	2	2	2	[illegible]	[illegible]	[illegible]	1	4	1	1	15	10
Mersin	1	2	1	2	2	1	[illegible]	[illegible]	1	2	1	1	14	10
Southeast Mountains:														
Elâzığ	0	0	1	2	4	1	1	[illegible]	1	2	0	0	12	10
Malatya	0	0	0	1	4	1	1	1	0	1	0	0	8	10
Van	0	[illegible]	0	0	1	1	1	1	2	1	0	0	5	10
Southern Plains and Hills:														
Diyarbakır	0	0	1	4	6	2	1	1	0	2	1	0	16	10
Mardin	0	0	0	0	1	1	0	0	[illegible]	0	0	0	2	10
Siirt	0	1	1	1	5	1		[illegible]	0	3	1	0	15	10
Urfa	0	[illegible]	1	1	1	0	0	[illegible]	0	1	0	0	4	10

Note: By international agreement a thunderstorm day is defined as a day on which thunder is heard.

* Station locations are indicated in Figure 5-3

usually present over rough terrain when wind speeds are greater than 20 mph. Such turbulence may on occasion be severe enough to present a hazard to flight for light aircraft. Thermal turbulence, produced by the differential heating of the underlying surface, is prevalent during the warmer part of the year and is especially well developed during late summer and autumn. It is most frequent and strongest in the interior regions, although it is not uncommon in any region in Turkey.

Strong vertical currents and turbulent, gusty conditions are not uncommon over the entire area. The cloud types which produce most turbulence are cumulus and cumulonimbus. These types are found most often over the Mediterranean coastal region and adjacent mountain slopes during the transition seasons and over the rest of Turkey in spring and early summer.

Orographic turbulence, while prevalent in the mountainous sections, seldom reaches to altitudes much above the friction layer. It may extend to high levels, however, on occasions when a strong wind crosses a mountain range. A phenomenon similar to a standing wave develops when strong winds from the northwest (60 to 80 knots at 10,000 ft) cross the eastern Taurus Mountains. On these occasions, turbulence over the mountains and over the Cilician Plain may become severe and extend to great altitudes. The situation is further complicated by the fact that the mountains are generally obscured by clouds, and considerable cloudiness in the form of long bands parallel to the mountain range lies over the plains. Clouds over the mountains are often in layers. However, data are not sufficient to permit the determination of the frequency of duration of this phenomenon. There are probably other localities in Turkey where standing waves occur.

Thermal turbulence, caused by the differential heating of the surface, is common over all of Turkey and is especially well developed during the summer. The altitude to which thermal turbulence extends is influenced not only by the elevation and character of the underlying surface but also by the stability of the air mass within which it occurs. In the warmer part of the year, comparatively cool air masses which pass over Turkey are warmed from below during the day and are made unstable. Turbulence in these air masses often extends to heights in excess of 10,000 ft above the surface in the Southeast Mountains.

5.1.3.8 Special Weather Phenomena

Special weather phenomena of a catastrophic nature are seldom recorded in Turkey. Damage resulting from gales, flash floods, heavy snowfall, and hail does, of course, occur, but the destruction commonly associated with hurricanes and tornadoes is unknown. Although tornadoes have been reported, they are so infrequent that the probability of one occurring in an area where it can cause extensive damage is slight. There are, however, some unusual meteorolegical phenomena observed in Turkey which deserve special attention.

5.2 TOPOGRAPHY, VEGETATION, AND CLIMATE OF SYRIA

5.2.1 Topography

Topographic features having climatic significance in Syria are the gently rolling desert and semidesert plains and ridges in the east and the narrow belts of coastal plains and mountains in the west. The mountains which parallel the Mediterranean coast are rather rugged and sparsely vegetated. The ridges rise to an average height of about 4000 ft, and some peaks are slightly over 5000 ft. In the south, along the eastern border of Lebanon, the crests average about 6000 ft with some peaks near 9000 ft.

5.2.2 Vegetation

The vegetation pattern of Syria is illustrated in Figure 5-2.

In the Central Plain, low shrubs and sparse grass with areas of cultivated vegetation consisting of olive groves, orchards, vineyards, and grainfields grow along the Orontes, Tigris, and Euphrates rivers and tributaries and in scattered areas in the west and north. Olive trees which are spaced 25 to 50 ft apart grow to heights of 15 to 20 ft. Fruit trees, which are leafless from mid-October through February, are spaced about 15 ft apart and grow to heights of 10 to 30 ft. Small patches of shrub grow near As Suwayda and marsh grass grows in the vicinity of Ghab Mustanga and al Ghab and a few other scattered areas.

Predominantly low grasses and shrub, with areas of scattered cultivated patches and some small patches of forest, grow in the northwestern highlands. Olive groves, vineyards, and grainfields are extensive in the north and are scattered along the coast. Other low crops and orchards are widely scattered in the south. Shrubs and small trees grow in a few protected places and are most pronounced at elevations above 4000 ft.

5.2.3 Climate

The weather and climatic regions of Syria are shown in Figure 5-4.

As a result of its location, there are two major types of climate in Syria—a Mediterranean climate along the coastal strip and on seaward slopes of the coastal mountains and a dry continental climate over the remainder of

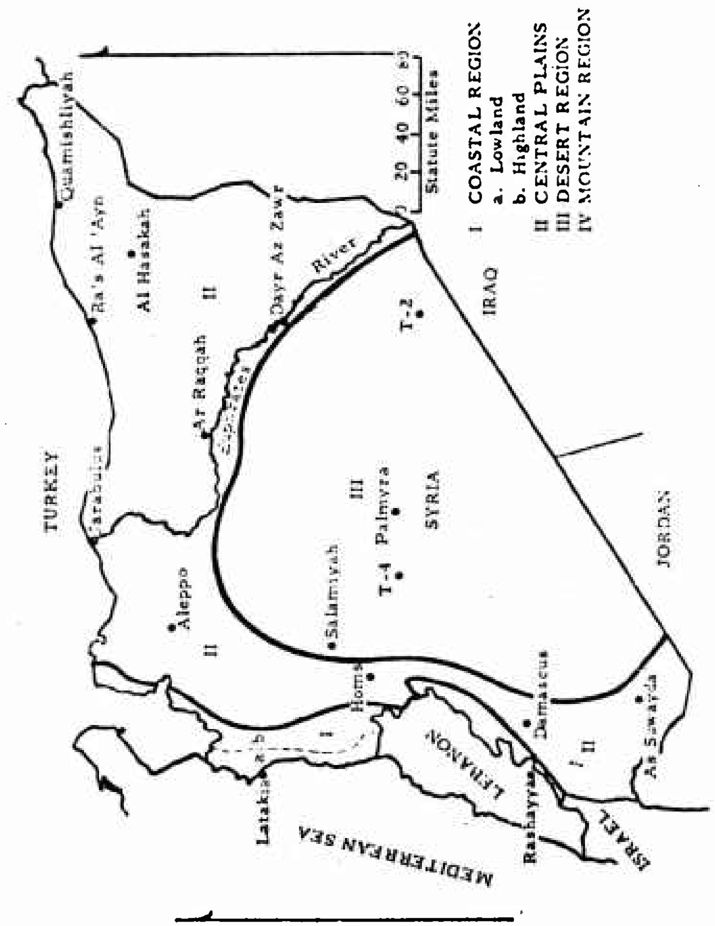


Figure 5-4 Weather and Climatic Regions—Syria

the country. The Mediterranean climate of western Syria is generally mild and moist during winter, which is the rainy season. Periods of generally clear weather alternate with spells of widespread cloudiness and rain accompanying the passage of cyclonic systems. Mean cloudiness and the occurrence of visibility restrictions and low ceilings are at a seasonal maximum; however, they do not seriously restrict most air operations. In summer, the cyclonic systems pass farther north, and the weather in western Syria is dominated by dry continental air brought over the region by the huge low-pressure trough centered over India. Hot and arid weather therefore predominates during the summer, except on the higher mountains where summer temperatures and drought are moderated because of the elevation.

Over the interior of Syria, the climate has a similar seasonal pattern, but with an even more restricted moisture supply, since moisture from the Mediterranean is largely blocked out by the coastal mountains of Syria and Lebanon. As along the coastal strip, the winter period is the season of maximum precipitation and cloudiness and of the most frequent low ceilings and restricted visibilities. The summer climate is typical of that encountered in most low-latitude desert regions, with an almost total absence of rainfall. Generally clear skies, torrid temperatures, and very low humidities prevail during the day, while nights are clear and relatively cool.

To facilitate discussion, Syria is divided into four regions, each having its own climatic and topographic characteristics: (1) Coastal Region, (2) Central Plains, (3) Desert Region, and (4) Mountain Region. The Coastal Region is made up of the Lowland and Highland Subregions (Figure 5-4). When specific reference to a particular region or subregion is not made, the discussion applies to all of Syria.

For the Coastal Region as a whole, mean annual precipitation is moderate in amount, the greatest amounts occurring in November through April. Summers are relatively dry; less than 0.5 in. of precipitation per month is recorded at most locations. Winters are mild with mean minimum temperatures in the 40s, and summers are warm with mean maximum temperatures reaching the upper 80s. Cloudy skies, low ceilings, and restricted visibilities occur more frequently during the cool season than during the warm season. The Lowland Subregion is a narrow strip of land, 5 to 30 mi wide, paralleling the coastline. It is interrupted at points where spurs of the Highland Subregion project westward toward the

sea. The Lowland has a characteristic Mediterranean climate in which winter and summer temperatures are considerably modified by the water mass. Eastward, the Highland Subregion acts as a topographic barrier to the maritime influences of the Mediterranean Sea. The western slopes of the mountainous Highland receive more precipitation than the eastern slopes and support more varied and abundant natural vegetation than any other part of the area.

The Central Plains is the region of transition between the Mediterranean climate of the Coastal Region and continental climate of the Desert Region. This region is dry and hot during the summer and mild and relatively moist during the winter. Most stations receive from 1 to 6 in. of precipitation per month during this season. Temperatures below freezing are not uncommon during the winter, and temperatures of 100° to 120°F. may be expected during the summer. Low ceilings and reduced visibilities are confined, for the most part, to the cooler months. This region is a rather monotonous, gently undulating steppe, mostly between 500 and 3000 ft above sea level. The difference between the Central Plains Region and the Desert Region is primarily a matter of mean rainfall.

The Desert Region, like the Central Plains, has the winter-rain and summer-drought precipitation pattern, but the total precipitation is less in the Desert Region. The mean temperatures are generally a few degrees higher in the desert than they are in other parts of the country. Water is extremely limited or lacking in most of the region. The Desert Region is irregularly marked by long, low ridges and sand dunes, and the surface is covered by endless stretches of sand, gravel, lava, or boulders with tufts of coarse vegetation.

The Mountain Region borders eastern Lebanon and comprises the eastern slopes of the Anti-Lebanon Mountains. These mountains crest at about 5000 to 7000 ft above sea level, with some peaks extending to heights between 8000 and 10,000 ft. Because the region is located in the rain shadow of the mountains, total precipitation is less than that received on the western side. Summer temperatures are decreased somewhat by the elevation, which is generally above 2000 ft. Mean cloudiness and the occurrence of restricted visibility reach a maximum during the winter months.

For the purpose of this discussion, unless otherwise stated, winter is defined as December, January, and February; spring as March, April, and May; summer as June, July, and August; and autumn as September, October, and November.

5.2.3.1 Clouds

One of the characteristics of both the Mediterranean and desert types of climate is an extensive and prolonged lack of cloud cover, especially during the summer months. Thus, Syria, like the other Mediterranean countries is not very cloudy. Table 5-15 gives the mean cloudiness at various stations. In all regions there is a pronounced variation in mean cloudiness between winter and summer. Winter everywhere has much greater cloudiness; mean monthly cloud cover varies from about 35% to 70%, with a tendency for the lesser amounts to occur in the south. Summer is the season of clear skies with mean monthly cloudiness varying from about 1% to 15% except in the Coastal Region where 20% to 40% coverage may be expected. As would be expected, the Desert Region is the least cloudy region in Syria; here the annual mean cloud cover is less than 30%. During the transition seasons, the spring decrease and autumn increase in cloudiness is normally a gradual process, with no sudden changes in the circulation pattern.

The principal cloud types over Syria are stratus, stratocumulus, and cumulus. Stratus and stratocumulus are most common along the coast and the western slopes of the mountains and are often associated with a migratory depression or frontal system. Inland over the Central Plains and Desert Region cumulus is the dominant cloud type. In winter, however, stratus clouds may be observed in the interior with the passage of frontal systems but ordinarily they are limited to the frontal zone.

The diurnal variation in mean cloudiness is shown for three regions in Table 5-15. These regions, which are representative of all of the area east of the mountains, experience minimum cloudiness during the evening and maximum cloudiness during the early afternoon. The cloudiness values for the morning hours approach those of the early afternoon and during winter are practically the same. Data on diurnal cloudiness variations in the Mountain and Coastal Regions are not available; however, the variation is believed to be similar to that of the other two regions.

TABLE 5-15

MEAN CLOUDINESS (%) AT SPECIFIED HOURS

REGION AND STATION+	HOUR (LST)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	YRS REC
Coastal Region:															
Latakia	1400	61	64	57	59	40	31	30	17	23	40	57	67	43	2
Central Plains:															
Aleppo	0800	69	61	41	50	37	7	3	5	6	37	54	68	36	5
	1300	69	69	50	62	50	13	4	8	17	45	55	67	42	5
	1500	56	54	34	39	31	5	2	3	3	29	41	50	29	5
	All hours	65	61	42	50	39	8	6	5	9	37	51	62	36	5
Al Hasakah	0800	60	54	38	49	35	7	8	4	7	31	49	57	32	5
	1300	54	62	47	58	52	16	12	5	12	36	56	50	29	5
	1800	44	48	34	37	40	11	9	4	4	31	42	47	29	5
	All hours	50	55	40	48	42	12	10	4	8	33	49	54	34	5
Damascus	0800	58	55	34	37	22	4	2	4	3	31	57	59	30	5
	1300	59	57	44	46	39	6	5	8	7	37	53	60	35	5
	1800	39	35	23	22	16	3	2	3	1	23	38	41	20	5
	All hours	52	49	34	35	26	4	3	5	4	30	49	53	29	5
Dayr Az Zawr	1500	54	62	52	51	46	13	3	3	19	36	50	55	37	2
	All hours	52	53	44	46	32	6	6	2	5	28	47	49	30	5-8
Homs	1400	65	68	62	66	47	26	18	12	25	44	64	65	46	2
	All hours	62	57	58	46	30	11	7	5	10	29	48	61	35	2-4
Qamishliyah	1500	60	67	66	57	49	26	15	11	26	44	53	63	45	2
Desert Region:															
Palmyra	All hours	56	60	42	46	38	10	4	6	3	30	53	55	37	5-7
Salamiyah	All hours	60	65	40	35	30	8	1	0	18	21	37	50	38	2
T-2	1100	39	40	41	44	24	1	13	1	11	24	49	38	37	1
T-4	1000	48	40	35	32	31	1	4	0	9	34	57	43	29	1

+Station locations are indicated in Figure 5-4.

TABLE 5-16

MEAN NUMBER OF CLEAR DAYS (≤0.3 CLOUD COVER) AT SPECIFIED HOURS

REGION AND STATION+	HOUR (LST)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	YRS REC
Coastal Region:															
Latakia	1000	16	10	16	14	18	16	16	15	18	22	13	17	101	1
	1400	10	7	11	8	14	17	18	24	22	18	11	8	164	2
Central Plains:															
Aleppo	1000	11	15	13	15	19	29	31	30	28	24	11	7	233	1
	1400	6	5	8	7	11	19	25	29	22	9	9	5	153	2
Al Hasakah	1100	12	11	10	16	22	28	29	31	24	26	9	8	225	1
Damascus	1000	10	10	17	17	20	29	30	31	23	18	11	11	238	1
Dayr Az Zawr	1400	13	8	11	10	16	28	30	31	24	18	8	6	205	2
	1500	12	[illegible]	10	9	12	24	29	29	21	17	11	[illegible]	195	2
Homs	1000	15	15	12	12	19	28	30	29	28	25	9	[illegible]	230	1
	1400	6	3	7	7	10	21	26	30	21	8	8	5	149	2
Qamishliyah	1500	9	7	6	7	10	18	25	28	30	14	10	8	181	2
Desert Region:															
Palmyra	1100	14	13	17	14	23	29	27	31	28	24	11	16	247	1
T-2	1100	16	17	18	13	23	30	27	31	26	22	12	18	252	1
T-4	1000	14	17	16	18	21	29	29	31	27	17	10	18	247	1

+Station locations are indicated in Figure 5-4.

Table 5-16 shows the mean number of days with clear skies equal to or less than 0.3 cloud cover at specified hours. May through September or October is definitely the best time of year for operations requiring clear days or days favorable to aerial photography. Little difficulty would be experienced in any region; the Desert Region would be the most favorable the year round, and the Coastal Region and the northern Central Plains generally the least favorable.

The daily average cloud cover for the month of December is shown in Figure 5-5 for three different reporting stations in Syria.

5.2.3.2 Visibility and Ceilings

Visibility

Visibility is considered good throughout Syria. Fog, dust, and haze are the primary factors limiting visibility and their occurrences are usually of relatively short duration. Percentage frequencies of specified visibility ranges for 0800, 1400, and 2000 LST are given in Table 5-17. The mean number of days with fog is shown in Table 5-18. Fog was not defined, but the limiting distance is believed to be 1100 yards or 5/8 mi. Visibilities of less than 5/8 mi occur most often in the river valleys of the northern Central Plains, such as at Ar Raqqah where up to 17% of the morning observations during winter report this restriction to visibility. At other locations the frequency of very low visibilities in winter ranges from 2% at Latakia in the Coastal Region to 12% at As Suwayda in the Central Plains.

In the interior regions, visibility is restricted most frequently during the winter and the transitional seasons, when dust and rain occur as a result of the sirocco and migrating storms. Along the coast during summer fog reduces visibility to less than 1 mi about 40% of the time, however, this coastal fog usually dissipates rather quickly after sunup, and by afternoon restricted visibilities are rarely experienced. In general, throughout the area visibility is best during summer and during the middle of the day, with approximately equal restrictions in the morning and evening hours.

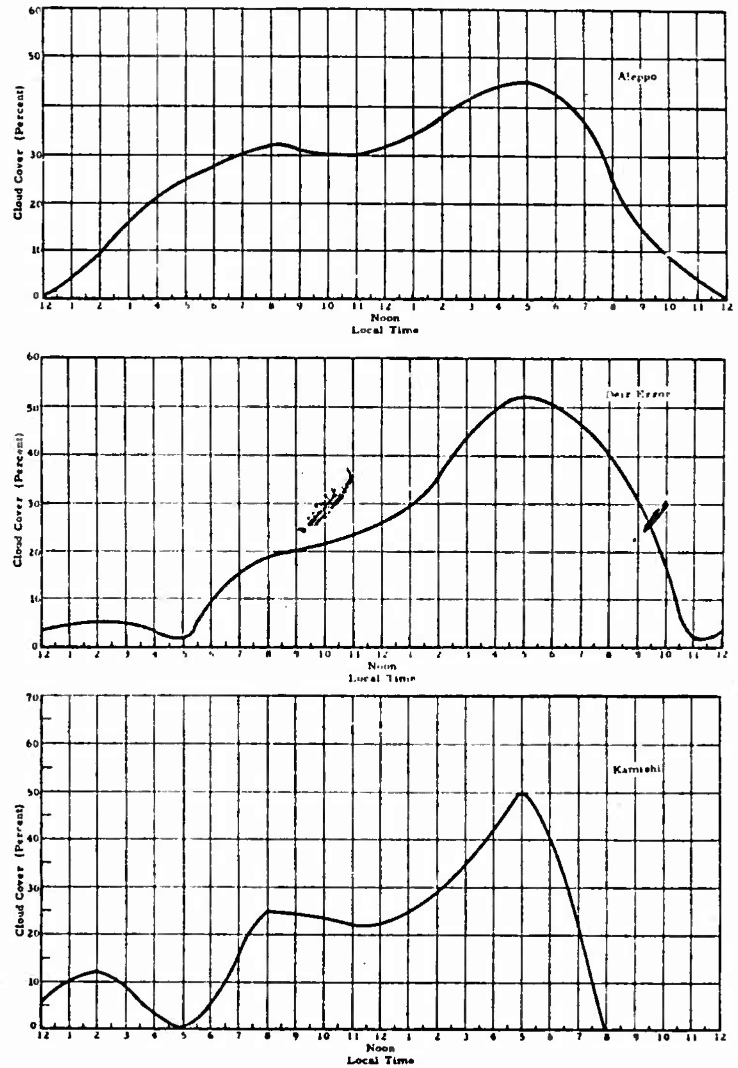


Figure 5-5 Daily Average Cloud Cover for Three Reporting Stations in Syria

TABLE 5-17
PERCENTAGE FREQUENCY OF SPECIFIED VISIBILITY RANGES AT SPECIFIED HOURS

REGION AND STATION+	HOUR (LST)	RANGE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	YRS REC
		miles														
Coastal Region: Latakia	0800	<5/16	2	1	1	1	1	1	1	1	1	2	1	2	1	[illegible]
		<1¼	3	3	3	4	2	2	1	2	1	3	1	4	2	
		<2½	9	10	9	9	6	7	4	9	4	8	7	12	8	
		<6	27	28	30	21	32	29	42	41	32	30	32	28	31	
	1400	<5/16	1	0	0	0	1	0	0	0	0	1	0	1	*	[illegible]
		<1¼	1	1	0	0	1	0	0	0	0	2	1	1	1	
		<2½	2	3	0	0	1	0	0	0	0	2	1	2	1	
		<6	12	7	4	5	7	2	1	0	1	4	4	6	5	
	2000	<5/16	1	0	0	0	0	0	0	0	0	0	0	0	*	[illegible]
		<1¼	1	0	0	0	0	0	0	0	0	0	0	0	*	
		<2½	2	0	0	0	0	0	0	0	0	1	0	0	*	
		<6	8	2	0	4	11	0	0	0	0	1	1	2	2	
Central Plains: Aleppo	0800	<5/16	5	5	1	1	0	0	0	0	0	1	3	10	2	[illegible]
		<1¼	7	6	1	1	0	0	0	0	0	1	3	11	3	
		<2½	9	8	2	1	0	*	0	0	*	1	4	13	3	
		<6	17	16	6	2	*	*	0	1	1	3	8	19	6	
	1400	<5/16	1	1	0	0	1	0	0	0	*	0	0	*	*	[illegible]
		<1¼	1	1	0	0	1	0	0	0	*	*	0	*	*	
		<2½	2	3	1	1	1	*	0	0	*	*	0	1	1	
		<6	7	5	3	3	2	*	*	*	*	1	1	7	2	
	2000	<5/16	2	4	5	6	1	1	0	0	0	*	0	1	2	[illegible]
		<1¼	4	5	5	6	2	2	0	0	0	1	*	7	3	
		<2½	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
		<6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
Al Hasakah	0800	<5/16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		<1¼	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
		<2½	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
		<6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	1400	<5/16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		<1¼	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
		<2½	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
		<6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	2000	<5/16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		<1¼	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
		<2½	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
		<6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
Ar Raqqah	0800	<5/16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3-4
		<1¼	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
		<2½	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
		<6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	1400	<5/16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3-4
		<1¼	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
		<2½	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
		<6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	2000	<5/16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3-4
		<1¼	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
		<2½	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
		<6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
As Suwayda'	0800	<5/16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6
		<1¼	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
		<2½	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
		<6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	1400	<5/16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6
		<1¼	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
		<2½	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
		<6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	2000	<5/16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6
		<1¼	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
		<2½	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
		<6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	

* <0.5%

+Station locations are indicated in Figure 5-4.

TABLE 5-17 (cont'd)

REGION AND STATION+	HOUR (LST)	RANGE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	YRS REC
		miles														
Central Plains (Western): Damascus	0800	<5/16	4	3	1	*	0	0	0	0	0	0	1	2	1	10
		<1¼	5	4	2	1	0	0	1	0	0	0	2	2	1	
		<2½	6	7	6	1	*	0	1	0	0	0	3	4	2	
		<6	15	16	7	3	1	*	1	0	0	1	5	12	5	
	1400	<5/16	1	*	0	0	0	0	0	0	*	0	0	0	*	10
		<1¼	1	1	0	0	0	0	0	0	*	0	0	*	*	
		<2½	2	2	*	*	*	*	0	0	*	0	0	*	*	
		<6	7	9	2	1	1	1	*	1	0	0	2	4	2	
	2000	<5/16	1	5	1	0	1	2	0	0	*	0	*	0	1	10
		<1¼	7	6	3	0	1	7	0	0	1	0	*	0	2	
		<2½	9	6	2	1	3	4	0	2	1	*	1	1	3	
		<6	18	10	3	8	6	6	2	4	1	1	4	8	6	
Dayr Az Zawr	0800	<5/16	5	2	1	1	*	1	3	1	*	0	4	12	3	10
		<1¼	8	4	3	1	1	1	4	3	2	*	4	12	3	
		<2½	8	5	4	3	2	4	10	6	5	1	5	14	6	
		<6	16	8	7	4	6	9	17	10	10	3	7	20	10	
	1400	<5/16	0	1	1	1	1	*	1	0	*	*	1	*	1	10
		<1¼	*	2	2	1	1	1	1	0	*	*	1	1	1	
		<2½	*	3	2	3	2	2	1	0	1	1	1	1	1	
		<6	2	5	8	5	5	3	7	1	3	1	2	2	3	
	2000	<5/16	7	4	1	0	4	1	0	0	0	0	*	4	2	10
		<1¼	9	4	1	*	5	2	0	1	0	1	1	4	2	
		<2½	10	4	1	*	6	2	*	1	0	1	2	8	3	
		<6	24	14	9	9	14	6	6	2	4	[illegible]	15	13	10	
Homs	0800	<5/16	9	5	2	1	0	0	0	0	0	*	2	8	2	10
		<1¼	10	7	2	1	0	0	0	0	0	1	2	10	3	
		<2½	11	10	2	1	*	0	0	0	*	1	3	11	3	
		<6	19	16	8	5	2	1	1	0	1	3	8	18	7	
	1400	<5/16	0	2	0	0	0	0	0	0	0	0	0	1	*	10
		<1¼	2	3	0	1	*	1	0	0	0	0	0	1	1	
		<2½	4	5	1	2	*	1	0	0	1	0	0	1	1	
		<6	13	11	6	5	3	2	3	0	1	3	2	7	5	
	2000	<5/16	3	4	*	*	1	0	0	0	0	0	0	3	1	10
		<1¼	4	9	1	2	1	0	0	0	0	*	1	3	2	
		<2½	8	13	5	6	3	1	0	1	1	1	1	5	4	
		<6	21	22	10	11	15	6	3	2	3	8	8	21	11	
Desert Region: Palmyra	0800	<5/16	4	2	1	0	0	0	1	0	0	0	1	3	1	10
		<1¼	6	2	1	*	0	0	1	*	0	0	1	4	1	
		<2½	8	3	2	*	0	1	3	3	0	*	2	5	2	
		<6	15	9	5	3	1	4	6	4	1	2	4	10	5	
	1400	<5/16	1	1	0	0	1	1	0	0	0	*	0	2	1	10
		<1¼	1	1	1	1	1	1	0	*	0	*	*	2	1	
		<2½	2	2	3	1	2	3	0	1	0	*	1	2	1	
		<6	6	7	5	5	4	4	2	1	*	1	2	6	4	
	2000	<5/16	2	1	1	1	1	1	*	0	0	0	1	2	1	10
		<1¼	4	1	1	1	1	1	*	0	0	0	2	2	1	
		<2½	6	2	2	2	1	1	2	1	0	*	3	2	2	
		<6	13	12	8	9	9	8	4	1	1	2	6	7	7	

* <0.5% +Station locations are indicated in Figure 5-4

TABLE 5-18
MEAN NUMBER OF DAYS WITH FOG

REGION AND STATION+	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	YRS REC
Coastal Region:														
Latakia	0	*	1	1	*	1	0	0	0	*	*	*	3	7
Central Plains:														
Aleppo	3	3	*	*	0	0	0	0	0	1	3	6	16	4
Al Hasakah	1	1	0	0	1	0	0	0	0	0	*	2	5	4
Damascus	3	1	*	*	0	0	0	0	0	0	1	1	6	6-7
Dayr Az Zawr	3	1	*	0	0	0	0	0	0	*	2	3	9	7
Homs	3	3	0	1	0	0	0	2	*	1	2	5	17	2-3
Desert Region:														
Palmyra	1	1	*	0	0	0	*	0	0	0	1	3	6	6

Note: Definition of fog unknown. +Station locations are indicated in Figure 5-4

* <0.5 day.

Ceilings

Winter is the season of maximum low cloudiness in Syria. The amount of cloudiness below 5000 ft, however, is seldom enough to form a ceiling (Table 5-19) and even low cloud layers constituting less than a ceiling are very infrequent (Table 5-20). The apparent minor conflicts between Tables 5-19 and 5-20 are probably due to the different and shorter periods of record for the data in Table 5-19. The data concerning cloud ceiling heights, although limited, indicate that the Coastal Region and the northern part of the Central Plains have a slightly greater frequency of low cloudiness than the other regions. Cloud heights below 1000 ft are rarely observed in any part of the area; less than 10% of the observations show heights below 1000 ft even during winter, the season of maximum cloudiness.

Elevated locations in the Mountain Region have a greater frequency of lower cloud heights because of the higher terrain; however, data to illustrate this are not available. Ceilings less than 5000 ft are seasonal, occurring primarily during the cooler months when as many as 55% of the afternoon observations have ceilings reported below this height.

Over the Desert Region, the low clouds are more apt to be scattered cumulus or, if more profuse, of a stratoform nature with a higher base, generally associated with the migratory winter depressions. During the warm season, the skies are practically clear. Low clouds occur more frequently during the early afternoon in all seasons and at all locations, but the cloud bases in the afternoon are usually higher than those that form during the morning hours.

The daily average surface visibility for the month of December for three cities in Syria is shown in Figure 5-6.

5.2.3.3 Surface Winds

The weak mean pressure gradient over Syria results in light and variable winds in all sections and in all seasons. The predominant surface wind direction at most stations in summer is westerly; during the winter, winds are easterly in the north and quite variable in the south. Local terrain features are important in determining the wind direction at many locations; for instance, at Homs the wind is channeled from the west through the Homs gap, the only natural gateway from the coast to the interior of

TABLE 5-19

PERCENTAGE FREQUENCY OF SPECIFIED CEILING* RANGES AT 1400 OR 1500 LST

REGION AND STATION+	RANGE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	YRS REC
	feet														
Coastal Region: Latakia	<1,000	0	0	0	0	0	0	0	0	0	0	0	0	0	2
	<5,000	45	33	22	24	21	19	15	7	8	12	18	40	22	
Central Plains: Aleppo	<1,000	5	7	3	0	0	0	0	0	0	2	2	10	3	2
	<5,000	54	64	47	42	19	15	4	2	8	30	23	48	29	
Damascus	<1,000	2	2	0	0	0	0	0	0	0	0	0	6	1	2
	<5,000	23	20	17	8	0	0	0	0	7	3	6	14	8	
Dayr Az Zawr	<1,000	0	0	0	0	0	0	0	0	3	0	0	7	1	2
	<5,000	23	33	31	27	17	2	0	0	9	8	18	28	16	
Homs	<1,000	2	4	3	0	0	0	0	0	0	2	8	4	2	1 2
	<5,000	50	47	44	30	14	3	0	0	4	9	31	41	23	
Qamishliyah	<1,000	4	9	8	3	3	0	0	0	0	0	2	6	3	1 2
	<5,000	17	40	42	28	23	16	8	2	8	22	28	31	21	

* Ceiling herein is defined as ≥5-tenths cloud cover

+Station locations are indicated in Figure 5-4

TABLE 5-20

PERCENTAGE FREQUENCY OF SPECIFIED HEIGHT RANGES FOR ALL LOW CLOUDS AT SPECIFIED HOURS

REGION AND STATION+	HOUR (LST)	RANGE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	YRS REC
		feet														
Coastal Region: Latakia	0800	<400	1	1	1	0	0	0	0	0	0	0	3	1	*	16
		<1,000	4	4	5	1	1	2	2	2	1	2	3	5	3	
		<5,000	52	56	43	44	45	47	60	58	47	44	45	52	49	
	1400	<400	0	0	0	0	0	0	0	0	0	0	0	0	0	16
		<1,000	0	2	6	1	0	0	0	1	0	0	2	0	1	
		<5,000	71	67	67	62	67	69	73	68	57	64	65	64	65	
	2000	<400	0	0	0	1	0	0	0	0	0	1	0	0	*	16
		<1,000	0	0	0	1	0	0	1	0	0	1	0	0	*	
		<5,000	64	63	60	63	57	48	74	54	41	64	65	52	59	
Central Plains: Aleppo	0800	<400	2	4	0	0	0	0	0	0	0	0	1	*	1	16
		<1,000	5	7	*	1	0	0	0	0	0	2	3	3	2	
		<5,000	48	49	34	24	22	9	8	8	18	32	40	43	28	
	1400	<400	0	1	0	0	0	0	0	0	0	0	0	*	*	16
		<1,000	4	3	1	2	0	0	0	0	0	*	0	2	1	
		<5,000	80	78	68	67	48	31	14	21	27	53	58	58	47	
	2000	<400	0	1	0	0	0	0	0	0	0	0	0	0	*	16
		<1,000	2	2	0	1	0	0	0	0	0	0	0	1	1	
		<5,000	40	41	33	26	22	11	8	4	8	26	28	38	23	
Al Hasakah	0800	<400	1	3	1	*	0	0	0	0	0	0	2	5	1	10
		<1,000	6	11	2	2	0	0	0	0	0	0	3	8	3	
		<5,000	36	47	27	24	14	4	5	3	8	24	29	40	22	
	1400	<400	*	1	0	0	0	0	0	0	0	0	0	1	*	10
		<1,000	2	4	1	0	0	0	0	0	0	0	*	1	1	
		<5,000	57	63	44	45	44	20	17	10	23	31	49	46	36	
	2000	<400	1	0	0	0	0	0	0	0	0	3	0	0	*	10
		<1,000	3	0	2	0	0	0	0	0	0	2	0	3	1	
		<5,000	30	40	28	28	24	22	15	0	8	16	31	30	24	
Ar Raqqah	0800	<400	4	0	0	0	0	0	0	0	0	0	1	5	1	3 4
		<1,000	5	0	0	0	0	0	0	0	0	0	1	8	1	
		<5,000	32	29	11	17	10	0	0	1	0	5	28	50	16	
	1400	<400	0	3	0	0	1	0	0	0	0	0	0	0	*	3 4
		<1,000	0	3	0	0	1	0	0	0	0	0	1	2	1	
		<5,000	35	34	22	41	30	0	0	0	11	31	33	46	26	
	2000	<400	0	0	2	0	1	0	0	0	0	0	0	0	*	3 4
		<1,000	0	0	1	0	1	0	0	0	0	0	0	6	*	
		<5,000	41	41	24	0	10	0	0	0	11	18	36	47	21	

* <.05% +Station locations are indicated in Figure 5-4

TABLE 5-20 (cont'd)

REGION AND STATION †	HOUR (LST)	RANGE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	YRS REC
		feet														
Central Plains (Continued) [illegible]	0600	< 600	4	2	0	1	1	0	0	0	0	0	1	1	1	6
		< 1,000	8	4	1	1	1	0	0	0	1	0	1	2	2	
		< 5,000	35	30	20	11	14	6	5	6	20	24	15	40	20	
	1400	< 600	1	1	*	0	1	0	0	0	0	0	0	0	*	6
		< 1,000	7	5	1	0	1	0	0	0	0	0	0	0	1	
		< 5,000	47	40	30	10	10	4	0	6	25	27	20	44	26	
	2000	< 600	7	4	1	1	0	0	0	0	0	0	0	0	1	6
		< 1,000	8	6	1	1	0	0	0	0	0	0	1	0	1	
		< 5,000	51	36	23	13	23	1	0	0	10	30	24	33	21	
Damascus	0600	< 600	7	7	0	0	0	0	0	0	0	0	0	1	*	16
		< 1,000	6	5	1	1	0	0	0	0	0	*	1	3	1	
		< 5,000	56	46	40	28	18	5	7	2	0	21	30	45	28	
	1400	< 600	*	*	0	0	0	0	0	0	0	0	*	1	*	16
		< 1,000	4	3	*	0	0	0	0	0	0	0	*	1	1	
		< 5,000	68	64	54	46	43	16	15	14	22	46	40	50	41	
	2000	< 600	0	0	1	0	0	0	0	0	0	0	*	0	*	16
		< 1,000	1	1	1	*	0	0	0	0	0	0	*	0	*	
		< 5,000	30	31	36	27	17	3	1	1	3	14	24	29	17	
Deyr Az Zawr	0600	< 600	1	2	*	0	0	0	0	0	0	0	4	5	1	16
		< 1,000	3	4	1	0	*	0	0	0	0	*	5	6	2	
		< 5,000	25	22	22	16	12	4	3	3	5	16	26	30	17	
	1400	< 600	0	0	*	0	0	0	0	0	0	0	*	1	*	16
		< 1,000	0	1	1	1	*	1	0	0	0	*	2	4	1	
		< 5,000	53	55	40	43	21	15	0	0	14	26	30	38	31	
	2000	< 600	1	0	0	1	0	0	0	0	0	0	0	2	*	16
		< 1,000	4	*	0	1	0	0	0	0	0	0	*	4	1	
		< 5,000	34	30	21	10	14	8	5	1	5	10	14	41	16	
Homs	0600	< 600	4	4	*	0	0	0	0	0	0	0	3	1	1	16
		< 1,000	14	10	4	3	1	0	0	0	*	*	5	4	4	
		< 5,000	55	50	46	30	30	[illegible]	25	30	30	31	40	45	47	
	1400	< 600	0	3	0	0	0	0	0	0	0	0	0	0	*	16
		< 1,000	5	5	1	0	1	0	0	0	0	1	*	1	3	
		< 5,000	60	70	53	41	45	34	51	55	30	47	65	56	50	
	2000	< 600	0	2	*	0	0	0	0	0	0	0	0	1	*	16
		< 1,000	1	7	1	4	1	0	0	0	0	*	0	1	1	
		< 5,000	50	56	34	30	35	16	23	23	17	24	38	38	33	
Desert Region Palmyra	0600	< 600	1	1	*	0	0	0	0	0	0	*	2	3	1	16
		< 1,000	6	4	1	*	0	0	0	0	0	1	5	6	2	
		< 5,000	40	30	26	18	16	1	2	3	6	26	30	41	20	
	1400	< 600	0	1	0	0	0	0	0	0	0	0	*	1	*	16
		< 1,000	3	4	1	*	4	0	0	0	0	0	1	3	1	
		< 5,000	22	54	41	40	45	16	17	12	17	40	44	41	35	
	2000	< 600	0	0	0	7	0	0	0	0	0	0	0	0	*	16
		< 1,000	3	1	0	3	0	0	0	0	0	0	1	2	1	
		< 5,000	42	34	33	24	17	8	4	3	4	21	20	37	21	

* < 0.5%   † Station locations are indicated in Figure 5-4 .

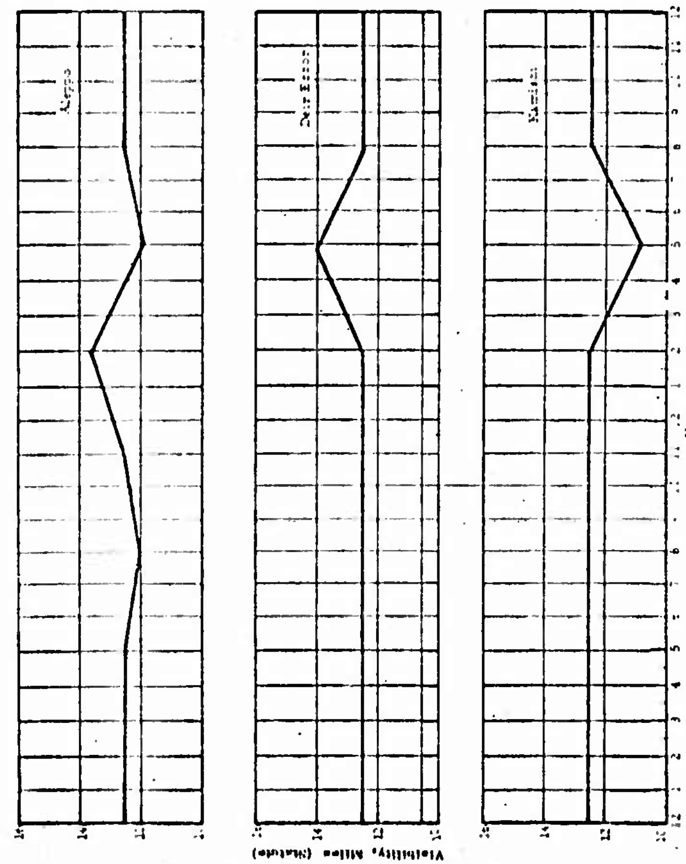


Figure 5-6 Daily Average Surface Visibility for Three Cities in Syria

Syria. At other locations the proximity of mountains and stream valleys influence the wind direction. Such locations as Damascus, Aleppo, and Dayr Az Zawr are thus affected to some extent.

Strong winds are not uncommon and usually occur with migratory depressions. In the mountains winds may be channeled into a restricted valley where the winds may reach gale force (28 knots or greater) suddenly and with great frequency. These winds especially affect stations in the Central Plains such as Homs where winds come through the gap in the mountains to the west, and along the Turkish border, where winds are affected by the mountains to the north. Gale-force winds occur most frequently during the cooler portion of the year and are usually associated with a migratory depression. Maximum winds are usually higher during winter and spring, when winds up to 50 knots have been recorded, than during the summer season.

Land and sea breezes occur along the coast throughout the year. In summer the sea breeze has a moderating effect on temperatures. The breeze may penetrate inland as much as 20 mi, depending upon the strength of the temperature gradient between land and sea. It usually begins during late morning and increases in strength until midafternoon, dying out near sunset. The main effect of the sea breeze is to reduce the maximum temperature and raise the absolute humidity. The evening counterpart of the sea breeze, the land breeze, usually rises by 2000 LST and lasts until morning. It is usually weaker than the sea breeze.

5.2.3.4 Precipitation

Rainfall is the most important climatic factor in Syria. The primary difference between the Central Plains and Desert Regions is in the potential rainfall and the availability of potable water. Throughout the country most of the precipitation occurs during the winter months with almost none during the summer. Most precipitation falls in the form of showers; only occasionally does rain fall steadily for long periods. Table 5-21 shows mean precipitation. The precipitation during any one month or year in Syria may vary widely from the mean monthly or mean annual amount.

The rainy season generally begins during October and ends early in May, with more than half of the annual precipitation being received during the winter months. Regionally, rainfall amounts are greatest in the

TABLE 5-21

MEAN PRECIPITATION (IN.)

REGION AND STATION+	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	YRS REC
Coastal Region:														
Latakia	6.7	6.8	2.6	1.7	1.4	0.6	0.2	0.2	0.2	1.2	3.8	7.7	32.9	10
Central Plains:														
Aleppo	2.6	2.4	1.6	1.3	0.4	0.1	0.0	0.0	0.0	0.7	0.9	3.5	14.4	4
Al Hasakah	1.4	2.0	0.5	1.3	1.0	*	0.0	0.0	0.0	0.2	2.4	1.2	11.8	16
As Suwayda'	3.0	3.2	1.2	1.1	0.1	0.0	0.0	0.1	*	0.2	1.8	2.3	13.3	9
Damascus	1.7	1.9	0.4	0.4	0.1	*	0.0	0.0	0.1	0.4	1.5	1.6	8.0	9
Dayr Az Zawr	1.6	0.9	0.3	0.0	0.1	0.0	0.0	0.0	0.0	0.2	1.4	1.0	6.3	8
Homs	4.0	3.1	1.3	1.1	0.2	*	0.0	0.0	*	1.6	1.8	1.9	14.4	6
Jarabulus	1.9	2.0	0.8	1.1	0.1	0.1	*	0.1	0.1	0.6	0.9	1.5	9.0	9
Ra's Al 'Ayn	6.2	3.2	3.5	0.6	0.1	0.0	0.0	0.0	0.0	1.2	5.2	4.6	24.5	7
Desert Region:														
Palmyra	0.7	0.7	0.1	0.2	0.4	0.0	0.0	0.0	0.0	0.3	0.3	1.0	3.7	5
Salamiyah	2.7	2.9	0.0	1.2	0.3	0.3	0.0	0.0	0.1	0.6	1.2	2.4	12.6	11
Mountain Region:														
Rashayya	5.0	5.9	2.6	1.8	0.7	*	0.0	*	0.1	1.0	2.9	3.6	23.6	7

* <0.05 inch.

+Station locations are indicated in Figure 5-4

TABLE 5-22

MEAN DAILY MAXIMUM AND MINIMUM TEMPERATURES (°F)

REGION AND STATION+		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	YRS REC
Coastal Region															
Latakia	Max	58	59	64	70	77	82	86	88	86	83	73	62	74	9
	Min	43	46	51	56	61	68	72	74	70	66	57	50	60	9
Central Plains:															
Aleppo	Max	49	55	60	73	84	93	98	98	91	82	68	53	76	4
	Min	32	37	40	46	56	62	69	69	61	53	44	37	51	4
Al Hasakah	Max	52	60	72	81	90	99	108	108	101	90	77	57	83	4
	Min	32	37	41	49	58	67	76	76	61	52	43	37	52	4
As Suwayda'	Max	51	53	61	68	79	85	87	87	83	79	66	56	71	8
	Min	39	40	44	48	56	59	63	65	60	59	50	42	52	8
Damascus	Max	53	57	65	75	84	91	96	96	91	81	67	56	76	13
	Min	36	39	42	49	55	61	64	64	60	54	47	40	51	13
Dayr Az Zawr	Max	51	58	70	80	92	99	105	104	97	85	71	58	81	8
	Min	35	38	42	52	61	70	77	76	68	56	48	38	55	8
Homs	Max	53	56	60	71	80	84	87	88	87	80	68	58	72	4
	Min	38	38	41	49	56	61	67	68	64	56	48	40	52	4
Jarabulus	Max	51	53	64	75	85	94	103	93	94	84	65	57	77	4
	Min	36	39	41	50	57	66	74	83	66	54	47	41	55	4
Desert Region:															
Palmyra	Max	54	60	72	81	90	96	101	102	94	84	74	63	81	5
	Min	36	38	43	52	61	66	69	70	65	56	47	38	54	5
Salamiyah	Max	60	64	63	71	84	90	94	96	90	81	68	55	75	2
	Min	35	38	39	46	51	59	64	66	59	51	44	37	49	2
T 2	Max	54	60	67	80	90	96	107	103	97	88	70	60	80	4
	Min	38	40	43	55	62	68	73	73	68	60	48	39	54	4

+Station locations are indicated in Figure 5-4.

Coastal Region, where 32.9 in. fall at Latakia, and in the Mountain Region. There is a gradual decrease in amount toward the Desert Region, both from the west and from the north.

Rainfall distribution is often affected by the terrain configuration. The Coastal Region, especially the Highland, receives more precipitation than the other regions of Syria, partly because of the available moisture in the air and partly because of the prevailing upslope motion of the air over the mountains. In the Central Plains and Desert Region the windward slopes receive more precipitation than the lowlands and leeward slopes. As Suwayda, and Rashayya, both elevated stations, average 13.3 in. and 23.6 in. annually; contrasted with these amounts are the 8.0 in. at Damascus on a leeward slope, and the 3.7 in. at Palmyra, on the nearly level desert. Air from the Mediterranean moves eastward without much modification to the moisture supply through the gap in the mountain system west of Homs. For this reason, Homs and Salamiyah receive more precipitation than the less favorably located stations to the south.

The number of days with precipitation is quite variable in Syria, not only from year to year but also from station to station. While the mean number of days with precipitation usually follows the trend of mean rainfall, in some cases the number of days may have little relationship to the mean annual rainfall. For example, Latakia has a mean of 61 days per year with precipitation of 32.9 in., whereas Salamiyah has the same number of days with precipitation with an annual total of only 12.6 in. Throughout Syria, the number of rainfall days is small compared to that in European countries such as France or England.

In the Mountain and Coastal Regions, sudden heavy precipitation may result in disastrous consequences, if equipment or personnel are located in stream beds which are normally dry. Precipitation as heavy as 6 in. in 24 hr may occur. Such downpours may result in sudden or overflowing of normally dry water courses, and at times the water advances downstream as a wall. The amount of abnormally heavy precipitation seems to be proportional to the expected total annual amounts (about 20% of the total value) but some deviations are indicated. For example, Dayr Az Zawr in the eastern Central Plains has recorded 3.8 in. in 24 hr, which is slightly more than half the expected annual total. All stations have recorded over 1 in. of sudden precipitation, even in the Desert Region.

Snowfall and snow cover occur in Syria, but for the most part snow is confined to the elevated sections. That which falls on the lowlands never remains long on the ground. Snow may remain through the year at the highest sheltered elevations in the mountains, but, although 3 to 10 ft may fall in other elevated locations, it is usually melted by mid-June.

5.2.3.5 Temperature

Syria has a hot summer and a mild winter and temperatures generally increase from west to east and from north to south. Several variables affect the temperature. Along the coast, the Mediterranean Sea has a moderating effect; in the Highland of the Coastal Region, in the Mountain Region, and at elevated points in the other regions, elevation and exposure often have a strong effect on the temperatures. Table 5-22 presents the mean daily maximum and minimum temperatures for Syria.

Temperatures show considerable variation from season to season and from region to region. The mean maximum temperature is highest along the coast during late summer, in August and September, but it is highest somewhat earlier, in July and August, in all other regions. Along the coast, the annual range of mean maximum temperatures is less than in other regions; at Latakia the range is about 32°F, from 88°F in August and September to 56°F in January. In the interior, this range is generally in the 40s or 50s at the lower elevations. Mean maximums in summer in the interior mostly range from 90° to 110°F with readings in the 80s at elevated stations. In winter, the mean maximums are mostly in the 50s or 60s, with mean maximums in the lower 40s on the higher mountains. Temperature differences between stations in the Central Plains and the Desert Region are not significant, because the temperature is more sensitive to station elevation than to station location.

Mean minimum temperature ranges are more conservative than mean maximum temperature ranges at all locations; however, they too reflect the location of the station in regard to elevation and exposure in the same way as the mean maximum temperatures. The lowest values occur in January in all regions of Syria. The interior lowlands have mean minimums in January in the 40s, with readings probably in the 20s on the higher ranges. The Coastal Region, reflecting the influence of the water mass, has mean minimums in the low 40s. In summer, mean minimums at low levels are in the 60s or 70s almost everywhere, with readings probably in the 40s on the higher ranges.

The mean daily temperature range is smallest along the coast and on the higher elevations where the moderating influences of the sea and elevation are greatest. The lower elevations in the interior regions have the largest daily range, with the maximum occurring during the summer or early autumn when radiational heating and cooling is greatest.

The absolute values of maximum and minimum temperatures reported do not give a reliable indication of the extremes which may occur in the future, because of the relatively short period of record at all stations. However, they do serve to indicate the severity of the summer temperatures in this desert environment. The extreme maximum temperatures have been recorded at most stations in July or August and exceed 110°F at all stations but those influenced by the sea or those at elevated locations, where extremes of 103° to 109°F were recorded. Two stations, Al Hasakah in the Central Plains and T-2 in the Desert Region, have recorded extreme maximums of 119°F. Over the desert surface, much higher temperatures, especially near the ground, may be expected.

The lowest extreme minimum temperatures usually occur in January or February. In all regions the recorded extremes fell below freezing during the winter season. Latakia, in the Coastal Region, reflects the influence of the water mass since the extreme minimum reported is only 30°F, as contrasted with the interior where extreme minimum values of from 9° to 23°F have been reported. Mountain locations, especially the higher peaks, may be expected to have temperatures below 0°F.

5.2.3.6 Relative Humidity

There are only a few stations in Syria for which relative humidity data are available (Table 5-23). Except for Damascus, the values represent the midafternoon condition, roughly the minimum daily value. In general, the amount of moisture in the air decreases with distance from the Mediterranean Sea; however, relative humidity values are also sensitive to temperature changes, varying inversely with the temperature. Generally, summer is the time of year for minimum relative humidity and the maximum usually occurs in winter.

The Coastal Region has sufficient moisture to maintain a fairly constant mean monthly relative humidity throughout the year. At Latakia the mean relative humidity at 1400 LST ranges from 70% in July, the

TABLE 5-23

MEAN RELATIVE HUMIDITY (%) AT SPECIFIED HOURS

REGION AND STATION +	HOUR (LST)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	YRS REC
Coastal Region:															
Latakia	1400	65	64	61	65	63	63	70	66	62	64	61	65	64	7
Central Plains:															
Aleppo	1400	78	65	60	54	40	38	38	40	44	56	64	80	55	2
Damascus	0800	81	78	62	50	44	45	43	47	48	54	73	81	59	5
	1400	57	53	42	32	26	22	19	21	24	31	45	59	36	5
Dayr Az Zawr	1500	76	65	61	46	38	33	31	34	40	46	55	71	50	2
Homs	1400	77	69	67	59	52	49	49	49	47	60	65	78	60	2
Qamishliyah	1500	72	71	62	52	46	36	34	36	34	49	58	70	52	2

+Station locations are indicated in Figure 5-4 .

TABLE 5-24

MEAN NUMBER OF DAYS WITH THUNDERSTORMS

REGION AND STATION +	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	YRS REC
Coastal Region:														
Latakia	4	7	4	6	3	3	*	1	3	4	4	7	46	9
Central Plains:														
Aleppo	1	1	1	3	4	1	1	1	2	5	2	1	23	4
Al Hasakah	0	2	1	2	4	0	0	0	*	2	1	1	14	4
Damascus	0	*	*	*	1	0	0	1	0	2	*	*	4	5
Desert Region:														
Palmyra	*	*	1	1	2	*	0	0	*	2	*	0	7	4

* <0.5 day. +Station locations are indicated in Figure 5-4 .

warmest part of the year, to 61% during March and November; the period of record is very short so that these mean values are probably approximations of the real values. Early morning values may be somewhat higher. In the interior regions the humidity varies with the season; values reach a maximum in winter and a minimum in summer. Diurnally, the pattern is similar to the seasonal fluctuation, with the cooler morning hours having the higher values.

5.2.3.7 Thunderstorms and Turbulence

Thunderstorms are rare during the summer months in all regions and throughout the entire year in the Desert Region and in the southern part of the Central Plains (Table 5-24). The year-to-year and month-to-month variations are large, partly because of actual differences in weather phenomena and partly because of the lack of a weather station network dense enough to adequately record thunderstorm activity. Most thunderstorms are associated with migratory frontal zones or depressions moving into the area. For this reason, Latakia in the Coastal Region records thunderstorms most often during winter and spring. However, in the northern Central Plains the greater frequencies of thunderstorms are recorded during the transition seasons.

Turbulence is associated with thunderstorms, fronts, convection, and strong winds over the rough irregular terrain. On hot summer days, there is considerable turbulence in the lower layers near the surface because of convective heating. This is particularly common over the Central Plains where desert surface and vegetation alternate to create differential heating at the surface. Cumulus-type clouds may or may not be present to indicate areas of convection because of the dryness of the surface air and the height of the condensation level. In winter the fronts and thunderstorms are often accompanied by moderate to occasionally severe turbulence.

Orographic turbulence is prevalent when winds aloft, especially in the layers 2000 to 3000 ft over the mountain surface, reach 30 knots or more. With stronger and persistent winds from the west, a mountain wave may develop in the lee of the mountains. Turbulence and dangerous up-and-down drafts usually accompany a mountain wave. The frequency of occurrence of mountain waves is unknown.

5.2.3.8 Special Phenomena

Special weather of a catastrophic nature is seldom recorded in Syria. There is minor damage from gales, flash floods, heavy snowfall in the mountains, and hail in the Lowland Subregion, but widespread destruction from weather phenomena is relatively unknown. However, several weather phenomena of an unusual nature are observed over Syria.

The sirocco (or simoom) is a dry, dust-laden southeast or east wind usually originating in the Arabian desert. The wind blows in advance of depressions as they pass eastward across the eastern Mediterranean. Siroccos occur most frequently from April to early June and from September to November, causing unseasonably hot weather and at some stations the highest temperatures of the year. The sudden onset of this wind may cause heat stroke. The first indications of the sirocco are a fall in atmospheric pressure as the depression approaches, a rapid decrease in humidity, and high thin cirrus clouds. The air quickly becomes hot and oppressive as the wind becomes stronger, occasionally reaching gale force. Dust accompanying the strong winds may reduce visibility considerably. With the passage of the depression, the wind veers sharply to the northwest, the temperature decreases rapidly, and often the dust clears, although winds may remain strong. The duration of a sirocco varies, but it may last for three or four days.

Mirages are frequently found in the desert and coastal districts of Syria, but they are seldom observed in the mountainous or vegetated regions because they depend on large horizontal or vertical temperature differences along the line of sight. Effects such as apparent elevation of the horizon, looming, and the superior mirage occur when the temperature lapse rate near the earth's surface is less than its normal value or, especially, when the temperature actually increases with height. This condition occurs over the sea with light offshore winds. The opposite type mirage, the inferior mirage or depression of the horizon, occurs when the temperature decreases rapidly with height. This type is most common over the deserts in the summer. Shimmering, another optical distortion, makes recognition and photography difficult under extreme conditions. It occurs when strong insolational heating of the earth's surface causes marked thermal turbulence in the surface layer of air.

SECTION 6

TOPOGRAPHY, VEGETATION, AND CLIMATE OF MALAYSIA AND INDONESIA

The region of Malaysia and Indonesia is shown in Figure 6-1. The topography, vegetation, and climate of Malaysia and Indonesia are discussed in Sections 6.1 and 6.2, respectively.

6.1 TOPOGRAPHY, VEGETATION, AND CLIMATE OF MALAYSIA

6.1.1 Topography

Malaysia consists of two parts, Malaya and Singapore on the one hand and Malaysian Borneo on the other, separated by nearly 400 mi of open water. Malaya and Singapore contain about 50,000 sq mi; Borneo contains about 75,000 sq mi.

Malaya has a hilly and mountainous interior flanked by coastal lowlands. The mountains consist of several roughly parallel, densely forested, north-south trending ranges which extend southward from the Thailand border for approximately two-thirds of Malaya's length, becoming narrow and discontinuous in the southern third. Lowland plains border the entire coast of Malaya and grade into the mountains of the interior through a belt of rolling hills. Singapore Island has a cultivated plain surrounding a central core of low forestedhills. The West Coast Lowland of Malaya averages about 40 mi in width, the East Coast Lowland about 20 mi. In the south, the lowland plains of the east and west coasts are seperated by isolated hills and mountain groups. There is also a larger interior lowland which extends northward from the southwestern coastal lowlands into the mountainous interior of Malaya. The lowland plains are cultivated for the most part, but have large areas of forest and swamp, locally interrupted by isolated hills and mountains.

Malaysian Borneo consists of high, rugged, densely forested mountains bordered by discontinuous coastal lowlands and interrupted by a few small interior valley plains. The mountains of Malaysian Borneo,

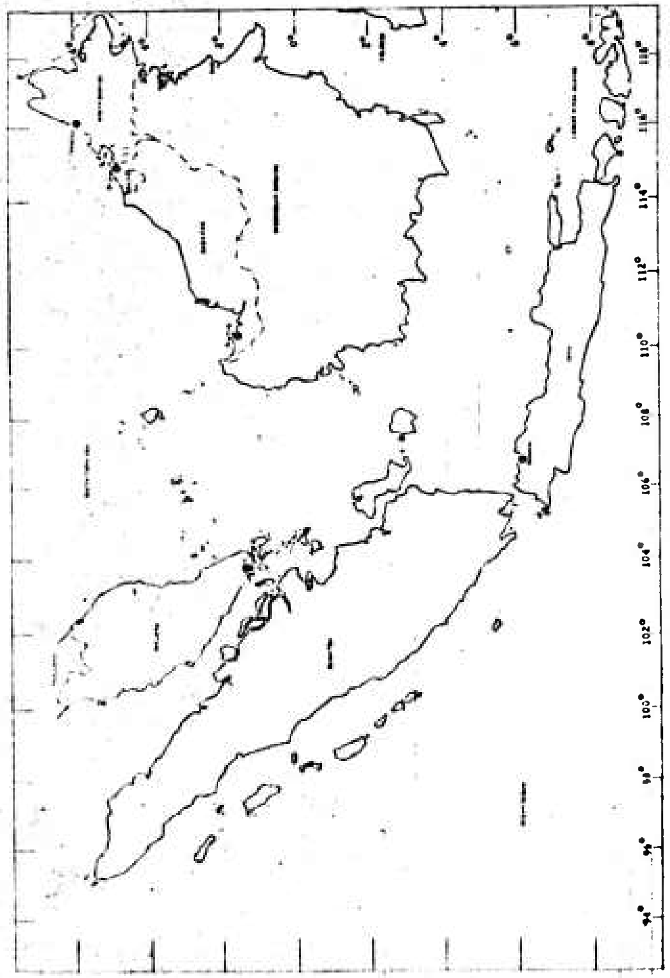


Figure 6-1 General Map of Malaysia-Indonesia Area

which comprise about two-thirds of its area, form a complex pattern of intersecting ridges and spurs. The principal ranges lie along the southeastern boundary of the area, eastward from Tanjong Datu to the extremities of North Borneo, terminating in the Crocker Range. The three major lowland areas, two on the west coast and one on the east coast, include the deltas of major rivers and extend for great distances inland, interrupting the continuity of the interior mountain ranges.

6.1.1.1 Topography of Malaya and Singapore

Mountains, hills, and lowland plains are the dominant landforms in Malaya. Mountains and hills occupy slightly more than half of the country, constituting nearly all of northern and central Malaya. These highlands, consisting mainly of three mountain ranges and adjacent hills, form a large, elongated, continuous, and rugged expanse which extends northward across the border into Thailand. Lowland plains and smaller areas of hills located principally along the east and west coasts and east of the Main Range in south-central Malaya comprise the remainder of Malaya and all of Singapore.

Highlands

The principal mountain range in Malaya, the Main Range, extends southeastward from the Thailand border for about 230 mi through west-central Malaya, forming the backbone of the country. Less extensive highlands flank the Main Range, principally the East Coast Range to the east and the Bintang Range to the west. Smaller, isolated mountain areas include Gunong Benom, which lies east of the Main Range in central Malaya, the Gunong Besar highland in the south-central part of the country, and the Blumut Range in the extreme southeast. General summit elevations in the mountains range from about 2000 to 7000 ft above sea level. Highest summit elevations are generally in the Main Range, where they vary from about 5000 to 7000 ft in the central part to between 3000 and 5000 ft in the north and about 3000 ft in the south. In the Bintang Range, summit elevations are commonly about 5000 ft. Elevations in the East Coast Range and in the Gunong Benom are generally 3000 to 3500 ft although peaks locally exceed 4500 ft. The highest peak in Malaya, Gunong Tahan, with an elevation of 7186 ft above sea level, is in the East Coast Range. Lowest of the mountain groups are the Blumut Range and Gunong Besar highland, which have elevations of 1500 and 2500 ft. Local relief in all the mountainous sections of Malaya exceeds 800 ft; it is as great as 1650 ft in the Main, East Coast, and Bintang Ranges. Slopes are generally greater than 30% throughout the mountains.

Lowland Plains

There are three major areas of lowland plains; the West Coast Lowland, the East Coast Lowland, and the Interior Plain. Nearly level to gently rolling surfaces characterize these plains, but low mountains and hills are scattered throughout. Principal lines of communication traverse the lowlands and follow the main north-south trending valleys in the hills and mountains.

Singapore Island and Other Offshore Islands

Numerous islands lie offshore from Malaya, the largest of which are Singapore Island, Penang Island, Pulau Langkawi, and Pulau Tioman. With the exception of Singapore Island and a few other low islands off the coasts of Malaya, the islands consist of rugged, central hilly and mountainous areas bordered by short stretches of narrow, level to gently rolling coastal lowlands. Mountainous sections are characterized by steep-sloped, sharp-crested ridges which attain maximum elevations of nearly 3400 ft on Pulau Tioman, 2900 ft above sea level on Pulau Langkawi, and about 2700 ft above sea level on Penang Island.

Singapore Island, located off the southern end of the Malay Peninsula, is separated from the mainland by the 3/4-mile-wide Johore Strait. The island is about 25 mi east-west and about 15 mi north-south; it is predominantly a level to gently-rolling plain. The plain is bordered on the seaward side, for the most part, by low mangrove swamps interrupted in places by low, gently to steeply-sloped hills. Elevation of the plain averages about 200 ft above sea level; the maximum elevation is 581 ft above sea level.

6.1.1.2 Topography of Malaysian Borneo

The surface configuration of Malaysian Borneo is shown in Figure 6-2.

High, rugged mountains are the dominant relief feature in Malaysian Borneo; mountains and hills together comprise a little more than two-thirds of the area. The remainder is mostly lowland plains and a few offshore islands.

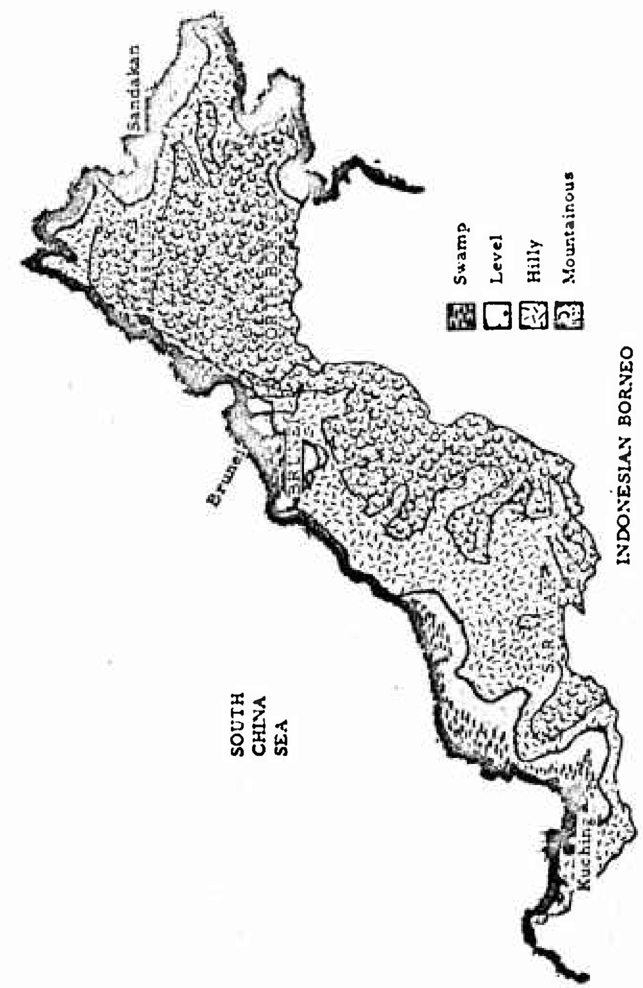


Figure 6-2 Surface Configuration of Malaysian Borneo

Highlands

The highlands of Malaysian Borneo, which fall naturally into three parts (Northeastern, Central, and Southwestern), are composed chiefly of mountains and hills extending as an essentially continuous mass through the area and along the boundary with Indonesian Borneo. In most of Malaysian Borneo, mountains descend abruptly to bordering foothills and then gradually to coastal plains. In a few places along the coast of northwestern North Borneo and in many places in the southeast, mountains extend to the coast, forming steep cliffs or headlands which completely or partially enclose narrow coastal lowlands.

Occupying nearly all of North Borneo, the Northeastern Highlands consist of high, steep-sided parallel ridges separated by narrow valleys. The longest and highest mountain mass in Malaysian Borneo is in these highlands; it is the 175-mi long Crocker Range in western North Borneo. The range is continous except where the Sungei Padas flows in a locally gorge like valley. On the northwest and north, the Crocket Range comes to within a few miles of the South China Sea Coast; spurs extend from the mountains to the coast where they end as cliffs and rocky headlands. In the extreme north, the range divides, one branch becoming the Sir James Brooke Range which extends northward as a peninsula west of Marudu Bay. The other branch of the Crocker Range consists of rugged hills and low mountains with steep, southwest-northeast trending ridges which extend from Marudu Bay to Labuk Bay. The highest point in Malaysian Borneo is Mount Kinabalu in the Crocker Range, 13,453 ft above sea level.

The Central Highlands, characterized by lower but equally rugged hills and mountains, extend generally northeast-southwest for about 150 mi, from the Crocker Range to Central Sarawak. The highlands average about 100 mi in northwest-southeast width with a maximum width of about 140 mi. They consist of steep-sided ridges with rounded crests. The principal ranges are the Apo Duat Mountains and Tama-Abu Range and the northwest-southeast trending Dulit Range.

In the area between the Batang Trusan and Batang Baram (rivers), a number of peaks exceed 5000 ft; Gunong Mulu, about 7800 ft above sea level.

The Southwestern Highlands consist of steep, heavily forest hills and mountains having general elevations between 1500 and 3000 ft, with peaks over 5000 ft. The principal components of the Southwestern Highlands are the Iran Mountains, the Hose Mountains, and the Upper Kapuas Mountains, all of which are rugged. Except for the Hose Mountains, only the portions of the ranges north of the drainage divide are included in Malaysian Borneo.

Coastal Lowlands

Lowlands are assocated with the coastal areas of Malaysian Borneo. They are continuous except along the western and southeastern coasts of North Borneo, where they are narrow and interrupted occasionally by mountain spurs, hills, and ridges. They are predominantly nearly level to gently rolling alluvial coastal and river plains. Many of them are poorly drained. Local relief is probably less than 100 ft and slopes less than 5%; both local relief and slope are considerably greater in spurs, hills, and ridges. The largest lowlands are the Labuk-Segama, Baram-Limbang, and Lupar-Rajang.

The Labuk-Segama Lowland extends about 150 mi northwest-southeast along most of the northeast coast of North Borneo. Portions of this generally swampy lowland are backed by better drained, nearly level to gently rolling areas with scattered hills and ridges about 200 to 300 ft high. Around Sandakan the lowland is narrow and partially enclosed by ridges up to 350 ft high. Inland, the lowland is bordered by densely forested hills and low mountains which are mostly steep-sided and rugged.

The Baram-Limbang Lowland is located in Brunei and northern Sarawak. It extends about 100 mi northeast-southwest along the coast between the southwest coast of Brunei Bay and Miri, and is from 2 to 25 mi wide. The lowland extends southeastward into the Batang Limbang Valley and into the marshy, nearly level to gently rolling flood plains of the Batang Baram Valley. Steep hills, 200 to 700 ft above sea level, interrupt much of the northeastern part of the lowland between Brooketon and Tutong. Along the coast in this section are narrow, sandy beaches backed by cliffs up to 120 ft high. West of Tutong, narrow, relatively well-drained sandy strips, about 1 mi wide, extend along the coast between the sea and the landward marshy areas. In the southwestern part of the lowland, there are isolated ridges and hills up to 200 ft above the plain. Hills and mountains, up to 2000 ft above sea level, rise behind the coastal plain and join the high, rugged interior mountains.

The Lupar-Rajang Lowland is largely a swampy plain. It extends for about 250 mi from near Bintulu to the southwestern border with Indonesian Borneo. From a minimum width of about 2 mi near both ends, the plain attains a maximum width of about 65 mi near the mouth of the Batang Rajang. Along the swampy coast are a few strips of narrow, slightly higher and better drained ground. Inland, well-drained areas are principally along the lower Batang Rajang near Sibu and in the southwest between the swampy coastal areas and the bordering mountains and hills. On it landward margin, the lowland is bordered by steep hills and mountains.

6.1.2 Vegetation

Almost all of the hills and mountains of the area and nearly half of the plains are covered with dense, broadleaf, tropical evergreen forests. These forests, characterized by trees generally over 60 ft high, form a dense, continuous canopy, tangled with woody vines. Undergrowth in sparse. Movement would be comparatively east for foot-troops but very difficult or impossible for vehicles. Much of the lowland area is swampy, particularly in Malaysian Borneo.

Extensive areas in Malaya and small areas in Malaysian Borneo are in grass or scrub or are devoted to crops; plantations occupy by far the largest portion of the cleared area. The largest expanses of cleared land are on the West Coast Lowland of Malaya where extensive areas of rubber and coconut plantations permit relatively free cross-country vehicular movement except during or immediately after a heavy rain. The ground throughout the area, however, is dominantly wet or moist during the entire year.

6.1.2.1 Vegetation of Malaya and Singapore

Forests cover most of Malaya. Nearly 75% of the total area is under dense natural forests. If plantations of tree crops, such as rubber, oil palm, and coconuts, which form essentially forest vegetations are included, the proportion of forest is at least 90%. Weedy thickets and tangled second-growth resulting from "shifting cultivation" cover considerable areas. Smaller areas are devoted to rice cultivation, mostly of the wet- or marsh-culture type. Still smaller proportions are in miscellaneous crops, such as bananas, pineapples, cassava, tea, and various fruits and vegetables. Small but increasing areas are unproductive cogon grassland, a result of clearing and repeated burning. Wastelands resulting from tin mining, with marshes, ponds, almost bare gravel and sand flats, and second-growth thickets, are also increasing in area.

The great forested areas are in the interior and in the eastern part of the peninsula. By far the largest portion of the Malayan forest is dense tropical rain forest, the natural vegetation of all well-drained areas at elevations up to 3500 and in places to 4000 ft. Large parts of the tropical rain forest are state-controlled forest reserves, some of which are being exploited for timber under careful management. In extensive poorly drained parts of the lowlands, fresh-water and mangrove swamp forests occur; neither of these is regarded as wasteland, as both are sources of timber and other products. In the mountains above 3500 to 4000 ft, forests consist largely of trees similar to those of temperate regions, mainly oak, and above about 5000 ft, mossy scrub forests of rhododendrons, myrtles, and similar small trees and shrubs prevail.

In a strip along the west coast of Malaya, 1/5 to 1/3 the width of the peninsula, and in areas adjacent to transportation routes elsewhere throughout Malaya and Singapore, the primitive forested condition has been largely altered by various human activities. Second-growth and crops of several kinds are commonest in the vicinity of the greater concentrations of population. Large rubber and palm plantations are located along the west and southwest coasts, as are the most extensive areas deforested by mining operations.

6.1.2.2 Vegetation of Malaysian Borneo and Brunei

Most of Malaysian Borneo is covered by forests. Extensive areas are covered by broadleaf evergreen topical rain forest, with a dense canopy and composed of many kinds of tall trees, mostly good hardwood timber trees. Other natural forest types are very diverse, ranging from mangrove and nipa palm in coastal swamps to mossy dwarf forest in the mountains. However, in many places the natural vegetation has been modified by human activities, including cultivation, burning and logging. The individual patches of the various resulting vegetation types are commonly too small to delinate at the scale used, and each vegetation type shown on the map is likely to comprise, even in one locality, a mosaic of several or many distinct kinds of vegetation. For example, cultivated or forested hills locally interrupt swamp areas.

The dominant natural forest type of well-drained areas is the luxuriant broadleaf evergreen topical rain forest. In poorly drained areas, fresh-water swamp forest occupies a belt of varying width, extending discontinuously along the coasts and reaching as much as 50 miles inland. The actual coastline, where muddy, is usually fringed by mangrove swamp forest, and where sandy, by beach ridges carrying a casurina forest. The higher parts of mountains which are persistently shrouded in cloud bear a stunted forest of twisted, branching trees and shrubs almost smothered in moss. The lower limit of this mossy scrub forest ranges in altitude from 3000 to 5000 ft, depending largely upon the exposure to the prevailing winds.

Approximately 17% of Malaysian Borneo is under some form of cultivation. A small part of this consists of permanent-tree crops, chiefly rubber but also coconut and sago palms. Of the area under herbaceous crops, however, very little is in permanent cultivation. By far the greater part of the subsistence farming of the natives takes the form of "shifting cultivation." This practice involves clearing the land, cultivating it for a year or two, and then letting it lie fallow for some years, during which it grows up successively to weeds, bushes, thickets, and scrub forest. This fallows period varies from two to three years in wet-land rice cultivation and from seven to twenty years in dry-rice culture. Thus most populated areas consist of a mosaic of small patches of scrub forest, thickets, and temporary clearings with cultivated crops. In general, less than 30% of any one cultivable area is under cultivation at any one time.

In general, the vegetation of Malaysian Borneo is similar to that of Malaya except that there is a narrow strip of casurine forest along parts of the coast and the coconut plantations are less extensive. The mapping information, however, is not adequate to permit presenting as detailed a picture of the distribution of the var ous types of vegetation as for Malaya.

6.1.3 Climate

The weather factor most seriously affecting ground operations in this area is the frequent heavy rainfall. Most annual rainfall exceeds 80 in. in most of the area and downpours of over 2 in. in a single day are frequent. Most places have had over 6 in. in a single day, and a few have had over 20 in. The persistent high temperature and humidity cause rapid deterioration of clothing and equipment, and may affect the morale and physical condition of personnel. Conditions are generally favorable for most air operations in this area. Although the average amount of cloudiness is large, the low clouds are predominantly cumulus; low stratus overcasts are rare except over limited sections of the interior of the large islands. Ceilings and visibilities are generally adequate except beneath cumulonimbus clouds, which are usually avoidable. The most important weather phenomena affecting air operations are the so-called convergence lines or zones often living across the area. These vary in intensity from narrow lines of towering cumulus clouds to wide zones of solid cumulonimbus clouds towering to great heights and accompanied by overcast altostratus layers. Penetration of a well-developed convergence line would be hazardous even for single aircraft because of the reduced visibility turbulence, and violent vertical currents. Their importance is intensified by the present-day dearth of basic knowledge as to their cause, composition, and physical process involved; thus, accurate forecasting of their formation, intensity, and movement is often extremely difficult. At intervals of several years, typhoons cut across the northermost and southernmost margins of the area. Once or twice a year they may pass close enough to the area to give overcast showery weather for a few days along the northern or southern borders.

Since temperatures vary only slightly from month to month throughout most of this area, there are no seasons as we know them in mid-latitudes. Instead, the seasonal weather changes are determined by the two great opposing airstreams, which originate in the semipermanent high-pressure centers of the Northern and Southern Hemispheres and converge along the intertropical convergence zone. With the changing midlatitude seasons the intertropical convergence zone (ICZ) migrates northward and southward. During the season when the ICZ lies farthest south, December through February, air from the Northern Hemisphere flows steadily over most of this equatorial area. In various regions, this airflow bears different names, according to its local direction; however, in this section, it will be designated the north monsoon. During March and April of an average year, the ICZ moves northward across the area, with the north and south monsoons each prevailing over part of the area. This period will be referred to as the spring transitional season for the area as a whole; the actual transitional period for localities in the south is earlier, of course, than for those in the north. From May through October, when the ICZ usually lies north of the area, air from the Southern Hemisphere flows over the area; this windflow will be called the south monsoon. Over most of the area the month of November is the autumn transitional season, as the ICZ moves southward across the area. In some localities, however, the passage of the ICZ may occur during October, or as late as December.

6.2 TOPOGRAPHY, VEGETATION, AND CLIMATE OF INDONESIA

6.2.1 Topography

Three major islands, Sumatra (Sumatera), Java (Djawa), and Celebes (Salawesi), and the Indonesian part of the island of Borneo (Kalimantan) comprise the bulk of Indonesia. Also within this area are the Lesser Sunda Islands (Pulau-Pulau Sunda Ketjil), the Moluccas (Maluka), and many small islands that lie adjacent to the larger islands and in the seas between them. The total land area of Indonesia is about 575,000 sq mi.

Certain topographic elements are found on nearly all the islands: mountains and plains, tropical forests, numerous streams, and extensive swamps. Active volcanoes are found throughout Indonesia, and earthquakes are more frequent in this area than in any other region on earth. On most of the islands of Indonesia, the settlements are small and near the coasts; the interiors are virtually uninhabited. Only one major island, Java, and the smallest islands adjacent to it, are densely settled and cultivated.

The southern tier of islands in the area has a generally northwest-southeast trending mountain backbone that extends from northwestern Sumatra to the easternmost of the Lesser Sunda Islands. The mountains are most continuous on Sumatra; plains and hills break the continuity on Java, and water channels separate the numerous smaller mountainous islands of the Lesser Sundas. Volcanic mountain masses and individual volcanic peaks, a number of which are active, are scattered throughout these mountains and are most numerous Java and in the Lesser Sundas. Wide lowland plains parallel the mountains except in the Lesser Sundas.

In contrast, the northern tier of islands in the area has no such linear arrangement of mountains and plains. Ranges radiate from the center of the main islands, and plains lie along the coasts in many places. There are few volcanic mountains in the northern tier of islands. Large parts of the northern islands are unexplored and poorly mapped.

Sumatra consists of three major parallel northwest-southeast trending belts of terrain which extend the length of the island: (1) rugged, densely forested hills and mountains paralleling the southwest coast, (2) mostly densely forested, partially cultivated, well-drained hills and rolling plains that become progressively lower and more level away from the mountains, and (3) low, flat, swampy plains cut by many streams and interconnecting tidal channels along the northeast coast.

The two island groups and two large islands off the northeast coast are predominantly low; some have sizable swampy areas. The string of islands off the southwest coast is hilly, with discontinuous coastal plains.

The island of Sumatra is composed of a high range of mountains flanking the southwest coast, a central zone of hills and rolling plains, and level, swampy, coastal plains on the northeast. These landforms extend northwest-southeast the length of the island as parallel belts.

The 1,025-mi long mountain backbone of Sumatra, the Main Range, rises steeply from the Indian Ocean and narrow coastal plains along the southwest coast of the island and extends inland about 50 mi. Sharp-crested branching ridges, rough steep slopes, volcanic cones, and narrow valleys characterize this chain of mountains. Crests are from 3000 to more than 10,000 ft above sea level. Local relief is from 500 to over 2000 ft and in most of the range it exceeds 1600 ft. Slopes over 30% are common.

The hills and rolling plains northeast of the Main Range constitute the Central Plains and Hills, a transitional belt between the mountains of the southwest and the flat northeast coast. The width of the hill area varies from a few miles in the northwest to 100 mi in the central part. The hills are generally smooth and rounded, and separated by narrow valleys. Locally, there are areas of level to gently rolling terrain and some steep slopes. Near the Main Range, the hills are from 1000 to slightly over 3000 ft above sea level and local relief is generally 500 ft or more. Farther east the hills are from 150 to 500 ft in elevation and local relief is generally between 100 and 500 ft. Most slopes are less than 10%.

Java, Madura, and Bali are the only parts of Indonesia with extensive concentraions of culture features. Java consists of densely settled, intensively cultivated plains interrupted by a discontinuous chain of individual volcanic mountains and mountain groups, between which the plains form north-south corridors. The western half of the island and parts of the southern coast have more continuous rugged hills and mountains and are less densely settled than the rest of the island. The plains, widest along the northern coast, and the terraced lower slopes of hills and mountains, mainly along the inland margins of the plains, are almost completely covered by wetland ricefields and thousands of agricultural villages. Hill and mountain slopes above the ricefields are less densely settled and are cultivated mainly in dry crops. Only the extremely rugged portions of the mountains are forested.

Bali and Madura, approximately equal in size, lie close to the east coast of Java. Bali has continuous areas of densely settled ricelands along its southern and northern coasts, but is mainly rugged, partially forested mountains. Most of Madura is hilly and intensively cultivated. Continuous coastal plains fringe the western half of the island.

Indonesian Borneo has a predominantly rugged, densely forested interior containing two large swampy basins and bordered by mostly swampy coastal plains. The inland margins of the coastal plains, widest in south-central Borneo, are well drained but also largely densely forested. The only significant settled and cultivated areas are a narrow strip near the coast in the southeast and one in the northwest.

Of the islands adjacent to Borneo, those near the coast are generally low and swampy, and those farther away are mountainous and densely forested.

Except in central Java, most of the mountains of the 600-mi long highland chain are volcanic, dominated by numerous high, symmetrical cones. Most peaks are between 6500 and 10,000 ft above sea level and a number are more than 10,000 ft. Gunung Mahameru, 12,060 ft, is the highest point on the island. Typically, the cones are not isolated but are so closely spaced as to form a cluster or long row. The upper slopes of these cones are steep, over 45%; the lower slopes are between 10% and 30%, and in places they merge imperceptibly with plains. Slopes are deeply ravined, the depth of the ravines increasing with elevation.

Hills are found throughout the highland chain, but they are continuous only along the northern edge of the mountains from Tjirebon west, along the eastern half of the south coast, and in the north from Kudus to Tuban. Although slopes in the hills are not so great over long distances as in the mountains, the elevations are generally much less, there are scattered areas of steep slopes within most of the hilly areas.

In western Java, volcanic mountains form a broad mass which almost completely encircles a number of relatively large basins. The northwestern and southern parts of this mass are irregular uplands 5000 to 8000 ft above sea level, with several peaks above 8000 ft. The terrain is rugged and marked by deep trenches and stream valleys; none, however, extend through the uplands. In the northeastern part, the encircling

mountains are more widely spaced, and several northward-flowing rivers and wide gaps separate the volcanic highland from the continuous upland to the south.

Most of Indonesian Borneo consists of exceedingly rugged highlands. The area has few peaks that rise over 8000 ft, but slopes are extremely steep throughout the greater part of the interior. The highlands, consisting of long and short broken ranges, vary in height, and nearly all the major ranges are crossed by low gaps and passes. Plains occupy a large area in the south-central part of the island and border most of the coasts; there are two basins of significant size within the highlands.

The major mountain chains and ranges in Indonesian Borneo trend east-west or northeast-southwest. Lower ridges branch out from the major ranges at right angles. Slopes of 30% and over are characteristic, and local relief is generally more than 1600 ft. Most summits are sharp; many of the higher mountains, however, have fairly flat tops. In the scattered limestone areas, found chiefly near Medang and the east coast, cliffs, caves, and sharp, knoblike hills are common.

The longest and most rugged mountain ranges form a chain generally following the boundary of Indonesian Borneo from northwest of the Upper Kapuas Basin to about the midpoint of the boundary with North Borneo. At intervals, passes cut through this chain. The Upper Kapuas and the Iran Mountains are the principal ranges in this chain. Most crests are 4000 to 5000 ft above sea level; some peaks may be higher. Ridges branch out from the southeastern side of the Iran Mountains and extend toward Makassar Strait (Selat Makasar). The westward continuation of the Upper Kapuas Mountains, along the southwestern boundary of Sarawak, consists of a much lower chain of mountains and hills with several gaps less than 300 ft above sea level.

6.2.2 Vegetation

Dense broadleaf evergreen forests cover most of the mountains, hills and well-drained parts of the plains on all of the islands except Java, Madura, Bali, and the Lesser Sundas. The forests are characterized by tall, closely spaced trees which form a dense continuous canopy interlaced with vines and rattans. Undergrowth is generally sparse. Above 7000 ft, shrubs generally predominate. The coastal plains of most of the islands are poorly drained and covered by dense swamp forests. The cultivated areas of Java, Madura, and Bali and the grasslands of the Lesser Sundas are the only extensive open areas in Indonesia.

Sumatra is heavily forested, about 70% of it being covered with evergreen forests. About 20% of Sumatra is cultivated land; much of this (e. g., rubber and coconut plantations) is also essentially forested. The remainder of Sumatra, about 10%, is grassland. The forests have been extensively cut, so that readily accessible straight timber of very large size is now mainly in the forest reserves, such as those of the Pegunungan Barisan.

In the dryland areas of Sumatra, the dominant forest type is a luxuriant broadleaf forest. Where undisturbed, such forests commonly contain trees as much as 150 or even 200 ft tall and 6 ft or more in diameter. The canopy is commonly very dense and the forest floor may be relatively open and free of underbrush. This forest type is characteristic of most well-drained areas at elevations below 3000 ft, although on sandy beach ridges, along parts of the southwest coast, there are pure stands of casuarina, a tree superficially resembling pine but having a very heavy, hard, reddish wood. Above 3000 ft, the forests are not as tall. On cloud-covered mountain slopes moss pervades the forests, and above 7000 ft the forests are scrubby tangles. The secondary forest that springs up on land that has been logged-over and burned or cleared and abandoned is a tangled scrub or rapidly growing trees heavily choked with woody and herbaceous vines, many of which are thorny. Deciduous forests are not present in Sumatra.

In poorly drained areas, fresh-water swamp and mangrove swamp forests prevail (swamp: an area of saturated ground dominated by trees and shrubs). Marshes (areas of saturated ground dominated by grasslike aquatic plants) are of very limited extend in Sumatra and are closely associated with the areas of fresh-water swamp.

The cultivated vegetation of Sumatra is largely tree crops, including rubber and palm trees, but some areas are in shrubs, such as coffee and tea, and some are in herbaceous vegetation, such as rice, bananas, and vegetables. Associated with the cultivated vegetation, and in large part resulting from cultivation practices of the Indonesian population, are areas of secondary forest and of grassland. Most grasslands of Sumatra are characterized by cogon grass, which is 2 to 4 ft tall at maturity and is generally burned over during dry periods.

Most forests of Sumatra have closely spaced trees and much undergrowth, often of thorny vines. This undergrowth grows rapidly in forest openings and in a few days may obscure trails. In some forests where the canopy is unusually thick, undergrowth may be sparse or nearly absent. In saline and brackish swamps along the coast true undergrowth is lacking but some kinds of mangrove roots are essentially like undergrowth.

Nearly three-fourths of the land surface of Java is under cultivation. About one-fourth is covered by forests, and about 1% is in grassland and savanna.

The forests of Java are partly evergreen and partly deciduous. At elevations above about 3000 ft, primary and secondary forests are evergreen and consist largely of broad-leaved trees, although conifers are mixed with these in some places, and locally pure open stands of casuarina grow on volcanoes. Dryland forests are elevations below 3000 ft include sparse deciduous forests along the eastern part of the south coast, and plantations of deciduous teak elsewhere. The swamps (areas of saturated ground dominated by trees and shrubs) of Java are not extensive. They are chiefly small mangrove swamps along the coasts.

In the extensive cultivated areas of Java, the most important single crop is wetland rice. In areas that cannot be irrigated, the greatest acreage is in corn (maize). Large areas are also in plantations of tree and shrub crops, including rubber, coffee, cinchona, and tea. Less important products include dryland rice and vegetables.

About 85% of the land surface of Indonesian Borneo is covered by evergreen forests. About 10% is cultivated land, including a large proportion of coconut and rubber plantations, which are essentially forested. The remaining 5% of Indonesian Borneo is grassland.

Much of the interior of Borneo is covered by a luxuriant broadleaf forest of trees as much as 200 ft tall and 6 ft or more in diameter. Where the canopy is very dense, the forest floor may be relatively open and free of undergrowth. This forest type is characteristic of much of the well-drained region at elevations below 3000 ft, but on sandy areas along the coast the typical vegetation may be a pure stand of somewhat scattered casuarine, a tree superficially resembling pine but having a heavy, hard reddish wood. Above 3000 ft, the forests are not as tall and in general have more undergrowth. On cloud-covered mountain slopes and ridges,

moss pervades the forests, and above 7000 ft the forests are scrubby tangles. The secondary forest that springs up on land that has been logged-over and burned or cleared and abandoned is a tangled scrub of rapidly growing trees, heavily choked with woody and herbaceous vines, many of which are thorny. Much of the forest readily accessible from the coast of Borneo is secondary forest. Deciduous forests do not occur in Borneo.

In poorly drained areas along the coast, mangrove swamps are abundant; behind many of these areas and also in river basins of the interior, fresh-water swamps (areas of saturated ground dominated by trees and shrubs) are extensive. Marshes (areas of saturated ground dominated by grasslike aquatic plants) are of limited extent within the areas of fresh-water swamp near the coast but are widespread in the interior river basins.

The cultivated vegetation of Borneo consists largely of tree crops, chiefly rubber and palm trees, but some areas are in herbaceous vegetation, such as rice, bananas, and vegetables. Associated with the cultivated vegetation, and in large part resulting from cultivation practices of the population, are areas of secondary forest and grassland. The cultivated areas on the upper reaches of rivers, as shown on the map, generally are clearings in forest. Most grasslands of Borneo are characterized by cogon grass, which is 2 to 4 ft tall at maturity and is generally burned over during relatively dry periods.

In forest openings where direct sunlight is admitted, undergrowth grows rapidly, and especially in secondary forest, small openings such as trails may be obscured in a few days. In saline and brackish coastal swamps, true undergrowth is lacking but some kinds of mangrove roots are essentially like undergrowth.

6.2.3 Climate

The area, consisting of four large islands, the western portion of New Guinea, and hundreds of smaller islands, stretches along the Equator for over 2700 n. mi and extends over 1000 mi from north to south. Despite this huge areal extent, the outstanding characteristic of the climate of this area is the monotonous uniformity of most of the climatic elements throughout the year, and for numerous elements throughout the area as well. Seasons as we know them in midlatitudes are unknown in this area; instead, the climate is dominated by a true monsoon circulation, with

two great airstreams, the north and south monsoons, each controlling the low-level circulation during part of the year. They converge toward the equatorial low-pressure trough, where they meet along the intertropical convergence zone, which migrates northward and southward with the changing seasons.

Local topography is the most important single influence upon the climate of any locality in this area. Because of the high moisture content, temperature, and marked convective instability of the air in the north monsoon and transitional seasons, very little lift is needed in most cases to produce cloudiness and rainfall, so that the form, orientation, height, and extent of the topographic features become very important. The ruggedness of the topography in Indonesia is an outstanding feature; the vast majority of the islands contain high mountain chains, with peaks rising 8000 to 12,000 ft along the island chain from Sumatra to Timor, 5000 or 6000 ft in Borneo, and over 15,000 ft in New Guinea.

Monsoonal flow directly against mountain ridges, especially during the north monsoon season, produces continual banks of clouds on the windward slopes and often over the peaks. This same effect is produced by the diurnal cycle, when air brought inland by the sea breezes produces banks of clouds, often towering cumulonimbus, on the slopes of the mountains. Conversely, downslope airflow produces a clearing tendency on the leeward slopes. Sometimes the foehn winds so produced are so hot and dry that crops in the leeward fields are completely destroyed. Foehn winds, under many different local names, are prevalent in sections of Sumatra, Java and Celebes, and on a smaller scale in many other localities. Throughout the area the monsoons cause much more rainfall and cloudiness on the windward sides than on the leeward sides of the islands, even though the difference in elevation may be only slight. This effect is so marked that on numerous islands, even some of small extent, the rainy periods occur in entirely different months on the opposite sides of the island. Ceram and the north arm of Celebes are two examples.

The topography also has a strong influence upon the surface winds throughout the area. Because of the intense surface heating, the sea breezes are so pronounced that the true large-scale circulation is often found only over the wider stretches of ocean. On the frequent occasions when the monsoonal circulation is weak the land and sea breezes are the dominant circulation, while otherwise the effect is merely to distort the monsoonal

flow. On the low, flat plains, such as in Borneo, Sumatra, New Guinea and parts of Java, the land breeze is very weak, and dead calms may occur. Extremely uncomfortable conditions are the result. On the other hand, where high mountains lie near the coast, the land breeze is remarkably steady and refreshing over the nearby lowlands. Where the flow is channeled by the topography, the land breeze occasionally attains destructive velocities.

Both monsoons have had sufficiently long journeys over tropical seas to be warm and moist when they arrive over this area. Therefore, the climate is characterized by remarkably high temperature and humidity throughout the year. During the north monsoon and the transitional periods between the monsoons, large amounts of clouds, frequent showers, turbulence, and thunderstorms are prevalent throughout the area. South monsoon air is characteristically drier aloft and less unstable than north monsoon air. In the southern part of the area, south of 4° or 5° S, the south monsoon brings a strong decrease in average cloud amounts and turbulence and a well-marked dry season. However, as the length of its passage northward over equatorial waters increases, the south monsoon becomes warmer, more moist, and more unstable, so that its contrast with the north monsoon diminishes. In the northern portion of the area turbulence and showers are frequent throughout the year.

The weather factor most seriously affecting ground operations in this area is the frequent heavy rainfall. Mean annual rainfall exceeds 80 in. in most of the area and downpours of over 2 in. in a single day are frequent. Most places have had over 6 in. in a single day, and a few have had over 20 in. Conditions are generally favorable for most air operations in this area. Although the average amount of cloudiness is large, the low clouds are predominantly cumulus; low stratus overcasts are rare except over limited sections of the interior of the larger islands. Ceilings and visibilities are generally adequate except beneath cumulonimbus clouds, which are usually avoidable. The most important weather phenomena affecting air operations are the so-called convergence lines or zones often lying across the area. These vary in intensity from narrow lines of towering cumulus clouds to wide zones of solid cumulonimbus clouds towering to great heights and accompanied by overcast altostatus layers. Penetration of a well-developed convergence line would be hazardous even for single aircraft because of the reduced visibility, turbulence, and violent vertical currents. Their importance is intensified by the present-day dearth of

basic knowledge as to their cause, composition, and physical process involved; thus, accurate forecasting of their formation, intensity, and movement is often extremely difficult. At intervals of several years, typhoons cut across the northernmost and southernmost margins of the area. Once or twice a year they may pass close enough to the area to give overcast, showery weather for a few days along the northern or southern borders.

Since temperatures vary only slightly from month to month throughout most of this area, there are no seasons as we know them in midlatitudes. Instead, the seasonal weather changes are determined by the two great opposing airstreams, which originate in the semipermanent high-pressure centers of the Northern and Southern Hemispheres and converge along the intertropical convergence zone. With the changing midlatitude seasons the intertropical convergence zone (ICZ) migrates northward and southward. During the season when the ICZ lies farthest south, December through February, air from the Northern Hemisphere flows steadily over most of this equatorial area. In various regions this airflow bears different names, according to its local direction; however, in this section, it will be designated the "north monsoon." During March and April of an average year, the ICZ moves northward across the area, with the north and south monsoons each prevailing over part of the Area. This period will be referred to as the "spring transitional season" for the area as a whole, the actual transitional period for localities in the south is earlier, of course, than for those in the north. From May through October, when the ICZ usually lies north of the Area, air from the Southern Hemisphere flows over the Area; this windflow will be called the "south monsoon." Over most of the area, the month of November is the autumn transitional season, as the ICZ moves southward across the area. In some localities, however, the passage of the ICZ may occur during October, or as late as December.

The climate of Indonesia is controlled by a true monsoon circulation between the high-pressure and low-pressure centers of Asia, the North Pacific Ocean, and Australia. During December through February the north monsoon prevails over the area, and from May through October the south monsoon prevails, flowing in almost exactly the opposite direction. The transitional seasons between the two monsoons occur in November and in March and April over the larger portion of the area, with some variation due to terrain and location. The characteristic features of each season are discussed individually.

North Monsoon. - The air masses that comprise the north monsoon originate in the Siberian high and the North Pacific high. The cold, dry polar continental air from the Siberian high moves in a long curve eastward and southward over the Western Pacific Ocean, arriving over this area from the northeast. The long journey over the warm tropical sea results in modification into an equatorial air mass, characterized by uniformity in time and space high temperature and humidity, and pronounced convective instability. On the rare occasions when the cold air moves south over the South China Sea, the air mass may retain enough density difference to produce a line of convergence along the mountains of northwestern Borneo. This line, consisting of cumulonimbus and limited altostratus decks, is important only in regard to flights to the west from Borneo. Tropical maritime air from the North Pacific high flows southward and westward toward the area, forming the current often known as the northeast trade winds. This air, also strongly heated and moistened by the equatorial waters, attains characteristics practically identical with the air from the Siberian high with which it merges.

South Monsoon. - The air masses that comprise the south monsoon, which prevails over most of the area from May through October, originate in the migratory highs of the Southern Hemisphere high-pressure belt, and especially in the semipermanent high over Australia. The topical continental air flowing westward and northwestward into this area from the Australian high is warm, stable, and exceedingly dry. The lowest layers are rapidly modified in passage over the warm equatorial waters. By the time the airstream reaches Java, the lower 2000 or 3000 ft is humid, though not as much so as the north monsoon air. However, the upper layers are still very dry; the relative humidity is often as low as 50% and sometimes as low as 20% to 30%. A characteristic feature of this air mass is a marked temperature inversion, with the upper limit between 6000 and 10,000 ft, which is quite persistent over the island chain from Pulau-pulau Tanimbar to eastern Sumatra (Sumatera) and sometimes covers the entire area. Because of the dryness of the air mass and the suppression of convective cloudiness by the inversion, the cloudiness and rainfall in this season is the lowest of the year at almost all locations in the area. The most pronounced effect of this dry air mass is the annual occurrence of a very dry and relatively cloud-free season in the lowland regions from Surabaja in Java eastward to Pulau-pulau Tanimbar. At most localities in this region, two or three months with less than an inch of rain occur on the average, most often in July through September. Kupang, in the driest section, has five months with an average rainfall below 1 in. As the dry air from the Australian high moves farther away from its source, it becomes increasingly moist and unstable, so that no other sections have a pronounced dry season, though most places in the area have their minimum rainfall and cloudiness from July through October.

Tropical maritime air from the Indian Ocean to the west and south of Java and Sumatra often flows over Sumatra and sometimes over Java and Borneo. This air has not been as strongly heated and moistened as that over the New Guinea section, so it is quite similar in properties to the air from the Australian high which has been modified by a long passage south of Java before turning northward. Thick cloudiness and heavy rainfall occur on the windward portions of Sumatra, and appreciable rainfall occurs throughout Sumatra, although this season as a whole has less rainfall and cloudiness than the others.

Transition Seasons. - The transitional seasons between the monsoon periods occur in November and in March and April as the ICZ moves north or south across the area. The circulation and the position of the ICZ in November, the autumn transitional season, are very similar, though the movement of the ICZ across the area from the north is generally accompanied by the belt of convergence lines as it moves north and south across the area, the portions of the area lying north of about 4° or 6°S receive their worst weather of the year during the transitional seasons. Most stations in this region, except those receiving heavy orographic rainfall during the north or south monsoons, experience their heaviest rainfall and greatest average cloudiness as the belt of convergence lines passes over them. Some stations have their worst weather during the spring transitional season and some during the autumn transitional season, but the increase in adverse weather is noticeable during both seasons at almost all stations crossed by the ICZ. Thunderstorms are very prevalent during these periods as a result of the frequent passage of convergence lines and the weak, variable circulation favorable for local convective thunderstorms. Surface winds are extremely variable during the transitional seasons, as one monsoon flow replaces the other at intervals until the advancing monsoon becomes established. Also, the weak circulation in and near the ICZ allows the land and sea breezes to exert a larger effect on the local circulation.

Tropical cyclones and, at rare intervals, typhoons may affect this area during the transitional seasons. In the north, the infrequent storms that pass over the northern Celebes Sea cause heavy rainfall, strong westerly winds, and high seas over northern Celebes and Halmahera and the islands to the north. They occur mostly during November and December. In the south of the area, tropical cyclones may pass over or form within the region of Timor and Pulau-pulau Tanimbar and move to the southwest during late March and April. Since almost all of these storm centers are in the formative stage, little damage results; but thick low clouds, heavy rainfall, and moderate seas may hamper operations for several days.

6.2.3.1 Clouds

In general, cloudiness in this area is favorable for most types of air operations. The cloudiness is primarily convective in origin and follows a very definite diurnal pattern at any one place. The cloudiness which results from lifting by the terrain is controlled by the air mass characteristics, the terrain, and the wind direction. Cloudiness over the water by day is seldom of great vertical extent, and the scattered thunderstorms can usually be circumnavigated. The worst weather condition for flight operations is the towering line of cumulonimbus clouds composing the convergence lines which move across the area. Thus, except for the moving convergence lines, most cloud conditions may be forecast from data on terrain, air masses, and winds. The convergence lines themselves, if intense, may generally be followed across the region with adequate weather reports and/or aircraft reconnaissance.

The diurnal pattern is quite regular at most locations. Thin stratus and fog starts forming after midnight over swampy valleys and upland basins, dissipating by 0900 LST in most cases. Convective cumulus form immediately over inland sections and the mountain slopes, and somewhat later over the coastlines. Inland cumulus grow rapidly and cover most of the sky by 1100 to 1400 LST, with probably a shower occurring. The clouds then dissipate through the afternoon. The coastal clouds follow the same pattern, with a later maximum of cloudiness. The clouds over the slopes of the mountains reach their maximum extent and height in the later afternoon; thunderstorms often form, and in many localities move toward the sea as the sea breeze dies if the monsoon circulation is toward the sea. After dark the convective clouds spread out and dissipate, though towering clouds over windward slopes of the ridges may remain throughout the night.

Over the sea, thunderstorm activity reaches a maximum at night, dissipating by 0900 LST in most cases. Cloudiness is greatly affected by the terrain, with windward slopes and coasts showing greater cloudiness than leeward slopes and coasts. Over mountain slopes the maximum cloudiness in most sectors occurs at terrain elevations of about 3000 to 6000 ft, where the cloud bases impinge against the mountains. The mountain tops may often rise above the clouds, but with strong flow and unstable air, the entire mountain may be covered. Operations planned to cross land sectors during the morning hours can thus avoid the thick cloud masses prevailing later in the day. Also, the clouds over the water generally dissipate in midmorning, permitting generally unrestricted flight at moderate altitudes above the small cumulus tops. Target forecasts will require careful consideration of the surrounding terrain, coordinated with the direction and velocity of the prevailing airflow, including the ever-present sea breeze during the day. Flights in cloud banks over mountainous terrain should be avoided, since the clouds may cover the ridge entirely. Convergence lines and zones are probably among the most important considerations in mission planning, though they are necessarily susceptible only to short-range forecasts.

Although adequate figures are not available on the regional distribution of cloudiness, it appears that, during the north monsoon maximum cloudiness occurs over the mountainous stations of Java and southern Sumatra, with considerable cloudiness also over Borneo. Clear days are rare in this region; the maximum occurrence appears to be over the Timor section, with six to nine days a month.

In the south monsoon season, however, Timor has an average of about 20 clear days per month, decreasing to six to nine days at Djakarta, and further decreasing to the west and north. However, the average cloudiness during the south monsoon season is decidedly less over the area and reaches very low values in the Timor section.

The mean cloudiness at specified hours is shown in Table 6-1. The frequency of broken or overcast low cloudiness is of concern to reconnaissance. Very few data on low cloud frequencies are available in this area. The frequency of occurrence of low cloud amounts 5/8 through 8/8 in 1949 is presented in Table 6-2. It is noted that only the station at Palembang, which is located very unfavorably in swampy terrain, shows average frequencies approaching 50%. The contrast between the north and

TABLE 6-1

MEAN CLOUDINESS (% OF SKY COVERED) AT SPECIFIED HOURS

ISLAND AND STATION	HOUR (LST)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	YRS REC
Singapore*	0900	72	60	60	63	65	65	66	67	68	71	71	68	66	10
	1500	79	70	68	66	68	64	63	66	67	66	74	75	69	10
	2100	57	47	46	44	48	44	41	46	50	51	55	55	49	10
JAVA:															
Djakarta	0700	76	78	65	57	52	49	45	44	46	52	63	71	58	39
	1300	78	78	70	64	60	58	53	53	53	60	70	78	65	39
	1800	81	80	77	70	63	57	50	49	57	69	81	83	68	39
Pasuruan	0800	64	66	59	42	45	32	28	21	22	34	45	57	43	10
	1300	56	61	50	37	43	28	27	23	24	34	47	55	40	10
	1800	91	92	87	73	65	47	39	38	42	56	79	88	66	10
BORNEO:															
Pontianak	0700	42	56	60	52	47	52	46	49	48	52	48	52	50	3-4
	1200	42	46	55	52	49	48	45	43	52	56	52	56	50	3-4
	1700	53	48	60	60	48	50	46	41	53	64	56	62	51	3-4
Balikpapan	0800	68	64	67	63	63	61	65	66	62	68	64	70	65	5-6
	1300	76	78	75	67	64	65	59	60	56	69	77	77	69	5-6
	1800	75	72	74	64	63	62	55	51	48	53	68	74	61	5-6
Tarakan	0800	57	56	54	62	61	65	62	62	64	62	67	59	62	9
	1300	66	61	60	66	61	57	55	53	54	59	64	65	61	9
	1800	54	43	51	49	47	43	41	40	42	48	50	44	46	10
TIMOR:															
Kupang	0800	39	35	30	11	12	10	11	5	5	7	12	30	17	15
	1400	40	36	35	20	20	18	18	11	12	18	26	40	25	15
	1800	44	41	45	22	19	17	16	12	14	19	28	44	27	15
CELEBES:															
Tomohon	0600	76	80	68	54	50	59	59	53	49	49	58	67	60	13
	1200	85	85	83	80	78	77	73	65	72	78	77	82	78	14
	1800	82	79	76	68	68	66	66	60	60	61	72	77	70	14

*Near but outside area of discussion.

TABLE 6-2

PERCENTAGE FREQUENCY OF 5/8 THROUGH 8/8 LOW CLOUDS (CLOUD BASES <10, 000 FEET) DURING DAYTIME HOURS

ISLAND AND STATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	YRS REC
SUMATRA:														
Medan	18	9	6	9	6	6	8	8	10	17	20	18	11	1
Palembang	15	33	29	18	31	25	40	19	36	19	37	40	31	1
JAVA:														
Djakarta	37	26	12	9	9	5	8	7	5	9	16	14	13	1
Surabaja	30	29	15	14	11	10	1	3	3	5	8	8	12	1
BORNEO:														
Balikpapan	8	3	8	8	7	19	29	24	22	21	12	11	14	1
TIMOR:														
Kupang	24	29	21	4	7	5	2	6	4	7	7	21	11	1
CELEBES:														
Makasar	37	29	24	24	25	12	12	3	5	9	11	21	18	1

TABLE 6-3

PERCENTAGE FREQUENCY OF CEILING <1, 000 FEET AND/OR VISIBILITY <1 1/4 MILES DURING SPECIFIED PERIODS

ISLAND AND STATION	PERIODS (HOURS LST)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	YRS REC
SUMATRA:															
Medan	0530 - 1830	2	2	1	1	1	7	3	5	4	3	5	3	3	1
Palembang	0600 - 1600	10	26	26	18	20	16	21	24	15	11	24	43	22	1
JAVA:															
Djakarta	0000 - 2400	7	3	1	2	3	2	1	1	1	1	2	2	2	1
Surabaja	0000 - 2400	5	4	1	1	*	1	*	0	0	0	2	1	1	1
BORNEO:															
Balikpapan	0530 - 1930	2	4	2	2	2	8	5	3	4	3	2	3	3	1
TIMOR:															
Kupang	0600 - 2000** 0000 - 2400***	5	3	*	0	0	*	0	0	0	0	*	*	1	1
CELEBES:															
Makasar	0000 - 2400	12	4	5	5	8	2	1	0	1	*	1	5	4	1

* <0.5%.
** Jan - Aug.
*** Sep - Dec.

south monsoons is very evident at stations in Java, Celebes, and Timor. Although these figures are not completely reliable and appear to be somewhat too low, they do indicate that a small amount of low clouds in the mornings and later afternoons probably compensates for larger amounts of the early afternoon. Visual bombardment and reconnaissance in this area would experience difficulties around noon due to increased low clouds, though the spaces between clouds might always be usable. The chances of success would be greater in early morning, and somewhat improved in late afternoon over inland sections, except over mountainous terrain. The local topography and wind direction would have a strong influence on cloud distributions.

6.2.3.2 Visibility and Ceiling

In this area, visibility is seldom a problem except during the south monsoon in excessively dry years, when widespread haze is introduced. Ground fog occurs at inland locations which are very moist, such as swamps and rivers, and occasionally over lowland sections recently moistened by showers. It also occurs in enclosed, upland basins, and in a few localities may impede operations. However, the fog generally dissipates soon after sunrise and is seldom thick enough after 0800 or 0900 LST to preclude visual bombing. A more serious condition is the widespread haze that develops in very dry years over the area, especially in the southeast. When this haze is very thick, it may seriously limit air-to-ground visibility in the southeast.

The haze is formed of salt particles from the sea, dust from Australia, and smoke from the brush fires, it imparts a whitish or bluish tint to the air, and during most years reduces the visibility to 8 to 10 miles. However, in dry years reduces the visibility to 8 to 10 miles. However, in dry years the increased dust may lower the visibility to 1 mile. The usual inversion at 6000 to 10,000 ft in this season forms the top boundary of the haze layer; above the inversion visibility is unusually good. The greatest haze density is usually between 3000 and 6000 ft. The haze increases in density as the season progresses, unless washed out by a widespread rainfall. It is densest in the Timor Sea, and usually extends as far as Sumatra. In exceptionally dry years it has covered the region as far as Singapore and northern Borneo. The first general rains of the autumn transitional season usually clean the air again.

The other main reason for reduced visibilities is the rain showers, which can produce near zero visibilities. However, these showers can generally be avoided. Widespread rain from middle clouds sufficient to greatly reduce visibilities is unusual and occurs mainly in connection with tropical storms, which are infrequent.

Ceilings and visibilities are generally adequate for air-ground operations in the area. Table 6-3 gives data on the low frequency of occurrence of combined low ceilings and/or visibilities. Only Palembang, located in swampy surroundings, show an appreciable percentage. Over the lowlands the bases of the cumulus clouds average 1500 to 2500 ft, with visibilities over 10 miles during the north monsoon and the spring transitional season. Ceilings rise toward the southeast, where Timor and the Lesser Sunda Islands (Pulau-pulau Sunda Ketjil) have ceilings averaging 2000 to 3000 ft. During the south monsoon season, ceilings are probably 2000 to 3000 feet over most of the lowlands, with 2500 to 4000 ft in the Timor region. Visibilities are generally over 7 miles, except when reduced by haze during dry years. In the vicinity of thunderstorms, most ceilings drop to 1000 ft and sometimes briefly to 500 ft, while visibilities may drop to below one mile for brief intervals. In the lowlands of the area, takeoff, and landing operations should encounter little difficulty, since thunderstorms normally obstruct the field for only short periods of time. Successful air-ground support with ceilings 2000 ft or lower would depend on other factors, such as the terrain, the type of aircraft, and the amount of turbulence present. On windward slopes, cloud bases often contact the ground, creating low visibilities. Conditions improve on leeward slopes, with ceilings and visibilities adequate. In the evenings and early mornings, the tendency at most inland sections is for clearing, though windward slopes may retain low ceilings during the night. In the south monsoon, stratus or stratocumulus clouds may form at the prevalent inversion where it intersects a mountain slope, creating low ceilings and possibly visibilities. While ceiling and visibility data are scarce in this area, the rainfall observation network is large, especially in Java; and because of the close correlation between rainfall and thunderstorms (the cause of most low ceilings and visibilities), very useful conclusions may often be extracted. Ceiling heights and visibilities undergo great variations in mountainous regions. On protected plateaus, ceilings are generally better than over the lowlands. However, peaks which are exposed to both monsoons may have almost continuous rainfall and low ceilings. A few peaks which extend above the cloud levels have a high percentage of adequate ceilings.

6.2.3.3 Surface Winds

The complex topography in this area, in conjunction with the weak character of the monsoon flows produces endless variations in the surface wind directions and velocities. The major influence is the sea breeze, which is generally quite evident except on those coasts where the sea breeze opposes the monsoon wind. Where the two factors operate in the same direction, surface winds over 20 mph are sometimes recorded. Land breezes are quite strong in some valleys or passes, especially about daybreak. However, surface winds are generally light during the day and calm at night in this area; noticeable velocities are the exception.

6.2.3.4 Precipitation

The frequent heavy rainfall in this area is undoubtedly the most important climatic factor in ground surface operations. Many roads are made impassible by mud. Roads, railroads, and encampments are flooded or washed away, airfields are eroded or flooded, and all operations are rendered more difficult. The tremendous amounts of rain that habitually fall in this area are seldom seen in most midlatitude countries. The mean annual rainfall over this area exceeds 80 in., and at least 12 stations in Java have recorded over 200 in. in a year. In general, the heaviest rainfall occurs on the inland slopes of Java, the west coast of Sumatra, interior Borneo, and interior New Guinea. Table 6-4 presents the mean monthly precipitation in tabular form. Rainfall amounts are greatly affected by topography; great differences in rainfall amounts are found at stations only a few miles apart. For example, annual rainfall at Palu, which is located in a protected valley and has probably the lowest rainfall in this area, is only 21.5 in., while annual rainfall at Pendolo, a mountain station located southeast of Palu, is 197.2 in.

While every locality has an individual precipitation regime based on local topography, the general pattern in a section is quite similar. The controlling influence on the rainfall pattern of this area is the movement north and south of the belt of convergence lines which lies north of the ICZ. A great part of the heavy rain occurs in these lines, convective thunderstorms in the stagnant air to the ICZ also contribute to the rainfall maximum. Thus, the maximum rainfall in Java and the islands south of about 4° to 5°S occurs when the ICZ lies to the south of Java and the Lesser Sunda Islands. In most cases, the maximum rainfall in regions to the north

TABLE 6-4

MEAN MONTHLY PRECIPITATION (INCHES)

ISLAND AND STATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	YRS REC
SUMATRA:														
Kutaradja	5.9	3.9	3.9	4.4	5.9	3.7	3.8	4.3	6.4	6.9	7.4	8.0	64.4	63
Medan	5.7	3.3	4.2	5.2	6.9	5.2	5.2	6.8	8.4	10.6	9.4	8.5	79.3	63
Singkil	11.7	10.6	14.3	18.0	14.4	10.5	11.1	14.7	16.0	21.7	20.7	15.2	179.0	51
Mangani	17.7	13.1	16.9	18.5	15.0	12.1	9.5	13.3	17.1	21.7	22.4	22.2	199.8	29
Padang	13.9	10.1	12.2	14.5	12.8	11.7	10.5	13.7	16.2	20.1	20.5	19.2	175.3	63
Lubukrusa	7.6	6.5	7.8	7.2	5.5	3.3	2.6	3.3	5.0	7.1	9.7	8.8	74.2	27
Lebongtandai	19.7	17.4	18.3	22.8	19.0	14.5	11.9	19.1	20.8	27.2	23.5	19.9	214.1	34
Sukadana	12.8	10.8	10.4	7.2	5.9	4.8	2.6	3.0	3.2	3.8	6.4	11.2	82.1	29
JAVA:														
Djakarta	11.8	11.8	8.3	5.6	5.2	3.8	2.5	1.7	2.6	4.4	5.6	8.0	70.6	63
Gunung Pangrango	15.8	17.4	17.2	12.9	7.7	4.7	3.0	3.5	4.9	9.4	13.7	17.6	130.9	30
Tendjo	30.4	25.4	26.9	25.7	21.3	13.0	10.8	9.3	15.8	32.5	34.1	33.2	278.3	26
Karanganjar	9.1	7.1	6.6	4.8	4.3	2.6	1.7	1.2	1.3	3.1	4.1	6.4	52.3	41
Kemuning	30.5	29.4	30.3	22.6	13.9	7.2	2.7	2.6	3.5	9.0	23.3	29.3	204.3	30
Kalidawir	9.5	9.8	7.8	5.5	3.0	2.1	1.4	0.5	0.7	3.0	5.0	7.8	56.2	46
Pasuruan	10.2	10.7	8.7	5.2	3.5	2.4	0.9	0.2	0.2	0.6	2.3	6.7	51.8	61
Asembagus	8.1	6.6	5.6	2.8	2.1	1.5	0.8	0.1	0.1	0.3	1.6	5.3	34.9	47
LOMBOK:														
Praja	11.0	9.8	8.4	6.2	4.3	2.3	1.7	1.2	0.9	3.0	6.5	12.6	67.8	28
BILLITON:														
Manggar	11.8	7.5	10.6	8.9	10.0	8.1	6.6	5.0	4.0	6.5	9.6	13.7	102.0	62
PULAU-PULAU ANAMBAS:														
Terampa	11.8	5.5	5.4	5.4	6.0	6.1	4.8	5.4	5.4	11.6	16.2	14.3	98.9	32
BORNEO:														
Pontianak	10.9	8.2	9.5	10.9	11.1	8.7	6.5	8.0	9.0	14.4	15.3	12.7	125.2	63
Sukamara	9.8	8.6	11.0	10.9	9.4	7.7	5.2	5.4	6.2	8.2	10.3	10.9	103.5	34
Bandjermasin	12.7	11.7	11.9	8.5	6.2	5.6	3.5	3.2	3.9	5.1	8.5	12.2	93.3	63
Balikpapan	7.9	6.9	9.1	8.2	9.1	7.6	7.1	6.4	5.5	5.2	6.6	8.2	87.8	43
Putussibau	15.3	14.6	14.8	17.0	13.9	10.7	8.6	10.4	11.7	17.6	19.0	17.3	170.9	40
Muaraantjalung	7.8	7.2	9.9	10.2	7.8	6.3	3.7	3.6	5.4	5.2	9.8	10.6	87.3	19
Tarakan	10.9	10.2	14.0	14.0	13.5	12.6	10.3	12.4	11.6	14.3	15.2	13.4	152.5	31
SUMBAWA:														
Bima	8.8	8.0	7.4	5.6	2.4	1.6	0.7	0.5	0.5	1.6	5.0	8.7	50.6	61
FLORES:														
Ruteng	16.4	17.0	18.9	14.5	8.1	5.0	3.7	3.0	4.4	9.0	14.8	17.0	132.0	26
PULAU SAWU:														
Seba	8.0	8.6	7.2	1.9	0.7	0.6	0.7	0.0	*	0.2	2.8	7.0	37.8	22
TIMOR:														
Kupang	15.2	13.7	9.2	2.6	1.2	0.4	0.2	*	*	0.7	3.3	9.1	55.6	63
Atambua	11.3	9.3	10.6	4.3	1.8	1.3	0.7	0.2	0.4	1.4	5.3	9.2	55.8	22
PULAU-PULAU TANIMBAR:														
Saumlakki	13.2	8.8	9.4	11.2	12.1	6.7	3.2	0.6	0.2	0.8	2.0	8.6	76.8	30
CELEBES:														
Borongroppea	14.4	13.9	16.1	17.2	25.2	23.3	13.4	6.8	2.3	2.0	5.3	13.8	153.8	17
Makasar	[illegible]	20.9	16.7	6.5	3.6	2.7	1.3	0.4	0.5	1.6	6.8	24.2	112.6	63
Kendari	7.2	7.0	7.8	7.1	8.2	7.6	4.7	2.4	1.1	0.7	2.7	6.7	63.0	34
Petolodo	14.7	14.2	20.6	24.6	17.7	11.5	7.7	5.3	5.1	7.2	12.6	17.1	197.2	29
Palu	1.8	1.5	1.5	1.9	1.9	2.5	1.8	2.0	1.8	1.3	1.8	1.6	21.5	33
Paleleh	14.0	14.3	11.1	9.4	8.5	7.9	7.5	6.1	5.5	5.7	11.1	11.5	111.7	40
Manado	15.6	13.8	12.2	8.0	6.4	6.5	4.6	4.0	3.3	4.9	6.9	14.7	106.2	63
PULAU SANGIHE:														
Tahuna	19.0	14.2	13.4	12.6	13.2	12.2	11.4	8.2	8.0	9.7	15.2	17.7	154.8	45
PULAU TIDORE:														
Ternate	8.3	7.2	7.6	9.3	10.2	8.3	5.3	4.1	4.4	5.3	8.0	9.1	87.0	63
PULAU-PULAU SULA:														
Sanana	4.8	4.2	5.4	6.8	11.6	8.7	6.4	3.1	3.3	2.4	3.8	5.2	67.7	24
AMBONIA:														
Ambonia	5.0	4.6	5.3	11.1	20.8	25.0	24.5	16.4	9.4	6.2	4.3	5.1	136.8	64
PULAU-PULAU ARU:														
Dobo	11.3	10.7	9.5	8.4	7.3	6.8	4.6	3.0	2.8	4.8	6.6	9.8	85.7	44
NEW GUINEA:														
Sorong	7.2	6.6	8.0	9.6	12.4	11.4	13.1	9.7	10.3	8.1	6.9	7.0	112.2	[illegible]
Atinjoe	15.1	10.7	11.5	18.4	20.6	21.0	14.1	17.2	17.1	8.2	9.6	15.2	[illegible]	6
Manokwari	12.0	9.4	14.2	11.1	7.8	7.2	5.4	5.6	4.9	4.7	6.5	10.4	[illegible]	10
Pomartowas	9.8	9.9	14.3	10.8	11.5	10.0	14.3	9.6	11.4	8.3	11.8	8.8	[illegible]	7
Hollandia	12.5	11.7	11.2	9.1	8.0	6.1	6.6	6.5	5.4	6.4	7.4	8.5	[illegible]	24
Kaimana	6.6	8.2	10.0	13.4	10.6	7.4	5.8	4.4	4.7	5.7	7.2	8.0	91.9	27
Nemtatie	23.6	13.9	17.6	23.4	20.5	23.0	23.0	17.2	26.7	14.0	18.1	18.7	249.7	6
Merauke	10.3	9.0	10.0	7.2	4.9	1.7	1.3	0.7	1.1	1.6	3.0	7.4	58.3	40

* < 0.05 in.

occurs when the belt of convergence lines moves northward or southward across the section; some stations have heavy amounts at both times. An exception to this regime occurs in the region around Amboina, where the highest amounts occur in the moist tropical airstream from north of Australia during April through July. The minimum amounts at almost all stations occur in the dry air of the south monsoon, although at many stations in the northern part of this area, the minimum is only slightly less than the maximum.

Rainfall may vary greatly from year to year in any one month, as the monsoons vary in strength and timing. During some years, crop failures resulting from late or missing rainfall are very serious in this area. While the number of days with rain is, in general, closely connected with the amount of rainfall, the connection is not always close. Stations on mountain slopes often have light rainfall for weeks on end, though total amounts are small. The Indonesia area has over 4000 rainfall stations in operation, but data are very sparse on other climatic factors. However, the rainfall data may be used to study a great many climatic problems in this area.

6.2.3.5 Temperature

The temperature regime in this area is chiefly remarkable for its constancy over such an enormous region and for its sustained high temperatures. Freezing temperatures have been recorded only on the higher mountains in the area. The mean daily maximum and minimum temperatures at various stations are presented in Table 6-5, as is the variation of the absolute maximum and minimum temperature throughout the area. Diurnal variations of temperature in this area are larger than variations between months. Stations located along the coasts generally have a smaller diurnal variation than inland stations because of the stabilizing effect of the sea.

6.2.3.6 Relative Humidity

The extremely high relative humidity in this area, especially during the north monsoon season and the transitional seasons, is probably the most irritating feature of the climate. Since surface winds are often light, little relief is obtained by evaporation and the high temperatures become very oppressive. Relative humidity values reach 90% or above

almost every night and fall to their minimum value in the afternoon. During August values at Balikpapan vary least because of the surrounding water, and Kupang, in the dry southeast, has the largest variation. Gunung Pangrango, typical of mountain stations varies little during the north monsoon season when clouds are frequent, but drops greatly in midday during the dry south monsoon season when the station is often cloudless. Table 6-6 presents in tabular form the mean daily maximum and minimum relative humidities.

6.2.3.7 Thunderstorms and Turbulence

This area is located too close to the equator to experience the full force of a mature tropical cyclone, which is termed a typhoon in the northern part of the area and a hurricane (locally termed a willy-willy) in the southern part of the area. At rare intervals, however, immature storms may pass across Pulau-pulau Talaud north of Halmahera and also form within the region around Timor and Pulau-pulau Tanimbar. Although winds in these storms are seldom destructive, several days of thick overcast clouds and heavy rain generally result. Destructive surface winds may accompany a mature typhoon or hurricane which passes just north of Pulau-pulau Talaud in its westward course or just south of Timor in its southwestward course. Thick cloudiness, heavy rain squalls, and high seas may accompany the passage of these storms. Tropical storms occur most frequently in November and December in the north, and during late March and April in the south. Typhoons which seriously affect the northern part of the area are very infrequent; in the Timor region the mean frequency is somewhat less than one a year. Because of their intensity, the mature typhoons or hurricanes usually give sufficient warning of their approach.

This area has one of the highest frequencies of thunderstorms in the world; all inland stations record over 100 storms a year and mountain stations in Java average as high as 322 a year. While they occur throughout the year, most places have a maximum during the transitional seasons, with many during the north monsoon as well. During these seasons the air is moist and convectively unstable. While many thunderstorms occur in the transitory convergence lines and zones, the usual location for convective storm formation is over mountain slopes. When the sea breeze dies down, thunderstorms frequently drift with the prevailing wind out to sea. Over water regions they are most frequent at night. In the tropics

TABLE 6-5

MEAN DAILY MAXIMUM AND MINIMUM TEMPERATURES (°F)

ISLAND AND STATION		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	YRS REC
SUMATRA:															
Takengon	Max	78	80	80	80	81	80	79	79	78	78	77	78	79	10
	Min	61	60	61	62	61	60	59	59	60	61	61	61	60	10
Medan	Max	85	87	89	89	89	88	89	89	88	86	87	85	87	10
	Min	71	71	72	73	73	72	72	72	72	72	72	72	72	10
Bukittinggi	Max	77	78	79	80	80	80	79	79	79	78	78	77	79	20
	Min	65	65	65	66	65	64	64	64	64	65	65	65	65	20
Gunung Singgalang	Max	55	55	57	56	57	54	55	57	55	57	56	55	56	2
	Min	44	42	46	45	46	45	45	46	46	46	45	46	45	2
Padang	Max	87	87	87	87	88	88	87	87	86	86	86	86	87	21
	Min	74	74	74	75	75	74	74	74	74	74	74	74	74	21
JAVA:															
Djakarta	Max	84	84	85	86	87	87	86	87	88	88	87	85	86	70
	Min	74	74	74	75	75	74	73	73	73	74	74	74	74	70
Gunung Pangrango	Max	53	54	54	56	57	57	57	57	57	56	55	54	56	21
	Min	44	44	44	45	45	44	43	43	43	43	44	44	44	21
Bandung	Max	81	80	81	82	82	82	82	83	84	84	82	81	82	22
	Min	67	67	67	67	66	64	63	63	64	65	66	67	65	22
Karanganjar	Max	87	87	87	88	87	86	85	85	85	86	86	86	86	17
	Min	74	74	74	74	74	72	70	70	72	73	74	74	73	17
Dijeng Plateau	Max	63	64	64	64	64	64	63	64	64	65	65	64	64	6
	Min	54	53	54	52	51	49	46	45	49	51	54	53	51	6
Pasuruan	Max	88	88	88	88	88	87	87	87	89	90	90	88	88	17
	Min	74	74	74	74	73	71	70	70	71	73	75	74	73	17
BILLITON:															
Manggar	Max	84	85	86	87	87	86	86	86	86	87	86	85	86	6
	Min	74	74	74	75	76	77	78	79	77	76	74	74	76	6
BORNEO:															
Pontianak	Max	87	89	89	89	90	90	89	90	90	88	88	87	89	20
	Min	74	75	74	75	75	75	74	74	75	75	75	74	75	20
Balikpapan	Max	85	85	85	85	85	83	83	83	84	85	85	85	84	6
	Min	73	73	73	73	74	73	73	74	74	74	73	73	73	6
Tarakan	Max	86	86	86	86	87	86	87	87	87	87	86	86	86	13
	Min	74	74	74	74	74	74	74	74	74	74	74	74	74	13
TIMOR:															
Kupang	Max	87	87	87	89	89	88	88	89	91	92	92	88	89	21
	Min	75	75	74	72	72	71	70	70	71	72	74	75	73	21
CELEBES:															
Makasar	Max	84	84	85	86	87	86	86	87	87	87	86	84	86	11
	Min	75	75	74	74	74	72	70	69	70	72	74	74	73	11
Tomohon	Max	76	76	78	79	80	79	79	80	80	80	80	77	78	13
	Min	65	65	65	64	65	65	65	64	63	64	64	65	65	13
Manado	Max	85	85	85	86	87	87	87	89	89	89	87	86	87	21
	Min	73	73	74	73	74	73	73	73	74	72	73	74	73	21
PULAU SANGIHE:															
Tahuna	Max	88	88	88	88	89	88	88	88	89	89	90	88	88	n.a.
	Min	71	71	71	72	72	72	72	72	72	72	72	72	72	n.a.
AMBOINA:															
Amboina	Max	85	86	86	86	84	82	81	81	83	85	87	88	85	21
	Min	76	76	76	75	75	74	73	73	74	74	75	76	75	21
NEW GUINEA:															
Manokwari	Max	86	86	86	86	86	85	86	85	87	87	86	86	86	5
	Min	73	73	74	74	74	74	74	75	74	74	74	75	74	5
Pionerbivak	Max	87	91	89	89	89	89	87	87	88	89	90	89	89	2
	Min	74	75	73	74	74	74	73	73	73	73	74	74	74	2
Prauwenbivak	Max	84	85	87	85	87	88	88	89	87	87	89	87	87	2
	Min	75	74	75	74	75	75	75	74	73	74	74	74	74	2
Merauke	Max	89	88	88	87	86	84	82	82	84	86	87	89	86	n.a.
	Min	76	78	77	75	76	75	72	70	72	71	74	74	74	n.a.

n.a. Data not available.

TABLE 6-6

MEAN DAILY MAXIMUM AND MINIMUM RELATIVE HUMIDITY (%)

ISLAND AND STATION		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	YR REC
SUMATRA:															
Takengon	Max	95	96	95	96	96	96	94	95	95	95	96	95	95	10
	Min	54	51	52	55	52	50	49	49	52	55	59	56	53	10
Medan	Max	95	95	95	95	95	95	95	95	96	95	95	95	95	19
	Min	61	56	55	57	57	56	53	55	59	61	64	63	58	19
Bukittinggi	Max	93	93	93	93	93	93	93	94	93	94	94	94	93	20
	Min	60	56	55	57	54	52	53	54	55	57	59	59	56	20
Gunung [illegible]	Max	100	99	100	100	99	100	100	98	100	99	100	99	99	2
	Min	78	70	73	78	68	82	74	72	84	82	80	87	80	2
Padang	Max	91	92	92	92	91	91	90	90	91	92	92	92	91	21
	Min	60	59	60	61	60	58	57	58	60	62	62	62	60	21
JAVA:															
Djakarta	Max	96	96	96	95	95	95	93	92	92	93	94	95	94	70
	Min	71	71	69	67	65	64	60	57	57	59	63	67	64	70
Gunung Pangrango	Max	98	98	98	98	96	95	91	94	96	96	97	97	96	21
	Min	76	76	76	68	59	55	46	45	48	60	68	71	62	21
Bandung	Max	94	93	94	93	93	93	92	91	91	92	93	92	93	22
	Min	58	59	58	55	54	52	47	44	44	47	52	57	52	22
Karanganjar	Max	96	96	96	96	96	96	96	96	96	96	96	96	96	14
	Min	66	65	64	65	66	65	63	62	62	65	66	66	65	14
Dijeng Plateau	Max	94	95	96	95	96	95	94	95	95	94	94	95	95	7
	Min	71	72	73	73	64	60	57	53	53	56	63	67	64	7
Pasuruan	Max	93	93	94	94	92	91	88	86	84	84	87	92	90	17
	Min	59	60	60	58	55	52	48	46	45	45	49	54	53	17
BILLITON:															
Manggar	Max	95	93	93	93	92	88	86	86	87	90	93	92	91	6
	Min	68	62	61	62	64	63	62	60	60	60	63	67	63	6
BORNEO:															
Pontianak	Max	93	94	94	94	94	94	94	94	94	94	94	94	94	20
	Min	60	57	57	58	58	57	55	54	54	58	60	62	58	20
Balikpapan	Max	97	97	96	97	97	96	96	96	94	93	96	96	96	[illegible]
	Min	64	62	63	67	68	70	71	68	65	66	64	62	66	[illegible]
Tarakan	Max	96	96	96	96	95	95	95	95	95	95	95	96	95	[illegible]
	Min	64	62	64	64	64	64	61	60	61	61	65	66	63	19
TIMOR:															
Kupang	Max	94	94	93	92	90	87	86	85	84	87	89	92	89	21
	Min	64	65	62	49	46	44	41	36	36	41	46	59	49	21
CELEBES:															
Makasar	Max	92	92	93	92	92	92	90	89	86	89	91	93	91	11
	Min	73	70	70	65	64	60	56	52	52	55	63	70	63	11
Manado	Max	95	94	94	94	93	92	89	87	89	92	94	95	92	21
	Min	69	67	67	67	65	62	57	53	54	57	65	68	63	21
AMBOINA:															
Amboina	Max	92	92	92	94	94	94	94	93	94	94	94	93	93	30
	Min	59	58	58	64	68	70	71	69	66	62	59	58	64	29
NEW GUINEA:															
Manokwari	Max	97	95	95	95	94	95	95	95	96	97	97	97	96	4
	Min	61	60	62	67	65	65	67	65	65	67	68	69	65	4

the thunderstorms tower to great heights, sometimes over 50,000 ft. Surface wind gusts in severe thunderstorms may reach 60 mph, and thus frequently cause local damage to housing and storage facilities. While moderate or heavy rain is observed in cumulus clouds that have not grown to great heights, the heaviest rainfall generally occurs in thunderstorms. The rainfall is torrential at times; at least 18 stations in this area have recorded 20 in. or more in a 24-hr period. Hail is very rare at the surface and infrequent in the upper air; in 87 cumulonimbus clouds penetrated by aircraft in this area, only seven contained noticeable hail. Aircraft icing is seldom a hazard in the typical isolated thunderstorm because of the short time the aircraft remains within the cloud; icing would probably be most dangerous in broad convergence lines composed of towering cumulus turning to cumulonimbus. Waterspouts and small whirlwinds are occasionally reported, but seldom do appreciable damage.

The mean number of days with thunderstorms is presented in tabular form in Table 6-7.

TABLE 6-7

MEAN NUMBER OF DAYS WITH THUNDERSTORMS

ISLAND AND STATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	YRS REC
SUMATRA:														
Medan	5	8	16	21	21	15	17	19	15	18	16	13	187	4
Singapore**	5	7	15	20	20	13	5	13	13	14	16	12	153	6
Bukittinggi	11	11	14	19	14	9	11	11	13	10	9	7	138	1
Padang	3	3	3	5	4	5	4	3	4	2	2	2	40	1
Palembang	5	7	14	14	10	8	9	7	6	12	14	9	115	8
JAVA														
Djakarta	13	12	14	14	12	8	5	5	7	13	16	13	132	60
Bandung	21	24	23	22	20	10	5	12	11	21	22	21	218	4
Surabaja	13	5	9	6	4	4	*	*	1	12	8	12	74	4
BORNEO														
Pontianak	5	5	9	9	7	6	4	5	7	8	6	2	73	4
Banjermasin	5	4	4	4	6	3	2	2	3	5	7	7	54	9
TIMOR														
Kupang	12	10	12	2	*	*	*	*	*	3	12	20	71	11-11
CELEBES														
Menado	1	2	2	4	4	4	2	2	4	6	6	1	38	6
AMBOINA														
Amboina	7	6	7	6	2	3	2	2	3	4	9	7	57	4
NEW GUINEA														
Manokwari	10	7	14	16	12	5	6	11	9	13	11	12	126	4

*<0.5 day.

**Near but outside area of discussion.

SECTION 7

STATISTICAL ANALYSIS OF TERRAIN-VISIBILITY CHARACTERISTICS

This study was initiated in response to a need for determining the line-of-sight coverage of sensory devices at various altitudes and in different types of terrain. Since one of the regions of primary interest to the BeTARS Project is Southeast Asia, it was decided to let South Vietnam serve as the area of investigation.

7.1 SOURCE MATERIAL

The research began with the acquisition of topographic maps representing three terrain types in South Vietnam, viz., (1) the Mekong Delta, (2) the Central Mountains, and (3) the Central Plateau. Two of the maps (Sheets 6653III and 6655II) were prepared by the Army Map Service, Corps of Engineers, US Army, on a Transverse Mercator Projection at a scale of 1:50,000 and a contour interval of 20 m with supplementary contours at 10-m intervals. The third map (sheet 6038I) was likewise prepared, but by the National Geographic Service of Vietnam. This series of maps is overlayed by a 1000-m Universal Transverse Mercator Grid which provides the basis of the analysis technique herein described.

7.2 DATA ACQUISITION

After delineating a 16 x 16 km (10-m square) representative sample area on the individual map sheets, all constituent grid points were located by UTM coordinates and their respective elevations were interpolated from adjacent contour lines. The location and elevation of each grid point were recorded on key punch cards for subsequent data processing. A Control Data G-20 high-speed digital computer was used in performing the analyses, and programs were written in a compatible FORTRAN language.

7.3 VISIBILITY ANALYSES

The first series of computer programs was concerned with line-of-sight determinations from the southern borderline looking northward along

the 17 grid lines. The first routine was set up to calculate how many of the 16 grid points on each grid line were visible from the observer's ground level position at the end point. It was assumed that a point could be seen if its sighting angle were greater than those of all the intervening points. A total of 272 points were thus examined from a given direction.

Visibility used in this analysis and the following data is the portion of the terrain, at the specified range from the observer, which can be seen. It is not the cummulative portion of terrain within view up to the specified range.

These slope measurements were repeated for 2, 4, 8, 16, 32, 64, 128, 256, 512, and 1024 m above ground level. Subsequent routines were introduced to analyze the visibility characteristics from the northern, western, and eastern borderlines in exactly the same manner as described above.

The statistical results in terms of mean visibility and standard deviation were computed for each set of 4 directional values for the 16 horizontal ranges of the various altitudes. Due to the limited number of samples, the results obtained from this simple technique should be regarded more as an indication of visibility conditions rather than an absolute evaluation of a particular terrain type. Further development of this technique is needed to perfect visibility definition. Nevertheless, the results appear to be entirely adequate for terrain comparison.

7.4 CENTRAL PLATEAU OF SOUTH VIETNAM

The sample area representative of the Central Plateau is designated on the map identified as Plei Bre, Series L701, Sheet 6653III, Edition 2-AMS, 1:50,000, July 1964. (Figure 7-1). The mean and deviation values of visibility from ground level were calculated as shown in Figure 7-2. These values were then plotted in conventional rectangular coordinates as a function of the corresponding range (Figure 7-3). It is quite evident from this curve that visibility from ground level is quite low in the plateau region.

Further analysis of the mean values for altitudes up to 1024 m above ground level reveals relatively little improvement in visibility in the first 32 m (Figure 7-4). It is interesting to note that beyond the 3-km range the visibility level remains fairly constant.

Figure 7-1 Plei Bre, Series L701, Sheet 6653 III,
Edition 2-AMS, 1:50,000, July 1964

Sheet 6653 III Central Plateau of South Vietnam	HORIZONTAL RANGE IN KM															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Visibility:																
W-E Looking N	1.00	.47	.17	.05	.23	.05	0	.05	.05	.05	.05	0	.23	.29	.11	.11
S-N Looking E	1.00	.23	0	0	0	0	0	0	0	0	0	0	0	0	0	0
W-E Looking S	1.00	.35	.23	.23	.23	.23	.17	.11	.17	.17	.17	.05	0	0	0	.05
S-N Looking W	1.00	.29	.17	0	.05	.11	.23	.05	.17	.35	.17	.17	.11	.17	0	0
Sum of 4 Directions	4.00	1.34	.57	.28	.51	.39	.40	.21	.39	.57	.39	.22	.34	.46	.11	.16
Mean of 4 Directions	1.000	.335	.143	.070	.128	.098	.100	.053	.098	.143	.098	.055	.085	.115	.028	.040
Difference From Mean:																
W-E Looking N	0	+.135	+.027	+.02	+.102	-.048	-.100	-.003	-.048	-.093	-.048	-.055	+.145	+.175	+.082	+.070
S-N Looking E	0	-.105	-.143	-.07	-.128	-.098	-.100	-.053	-.098	-.143	-.098	-.055	-.085	-.115	-.028	-.040
W-E Looking S	0	-.015	+.087	+.16	+.102	+.132	+.070	+.057	+.072	+.027	+.072	-.005	-.085	-.115	-.028	+.010
S-N Looking W	0	-.045	+.027	-.07	-.078	+.012	+.130	-.003	+.072	+.207	+.072	+.115	+.025	+.055	-.028	-.040
Difference Squared																
W-E Looking N	0	.018225	.000729	.0004	.010404	.002304	.01	.000009	.002304	.003025	.002304	.003025	.030625	.030625	.006724	.0049
S-N Looking E	0	.011025	.020449	.0049	.016384	.009604	.01	.002809	.009604	.020449	.009604	.003025	.007225	.013225	.000784	.0016
W-E Looking S	0	.000225	.007569	.0256	.010404	.017424	.0049	.003249	.005184	.000729	.005184	.000025	.007225	.013225	.000784	.0001
S-N Looking W	0	.002025	.000729	.0049	.006084	.000144	.0169	.000009	.005184	.042849	.005184	.013225	.000625	.003025	.000784	.0016
Sum of Squared Differences	0	.031500	.029476	.0358	.043276	.029476	.0418	.006076	.022276	.072676	.022276	.0193	.0361	.0601	.009076	.0082
Variance (Mean of Sq Diff.)	0	.007875	.007369	.00895	.010819	.007369	.01045	.001519	.005569	.018169	.005569	.004825	.009025	.015025	.002269	.00205
Square Root of Variances (Rms or One Standard Deviation)	0	.089	.086	.095	.104	.085	.102	.039	.075	.135	.075	.069	.095	.123	.048	.045
−1 σ		.249	.057	-.025	.024	.013	-.002	.014	.023	.008	.023	-.014	-.01	-.006	-.02	-.005
+1 σ		.424	.229	.165	.232	.183	.202	.092	.173	.278	.173	.124	.18	.238	.076	.085

Figure 7-2 Ground Level Visibility

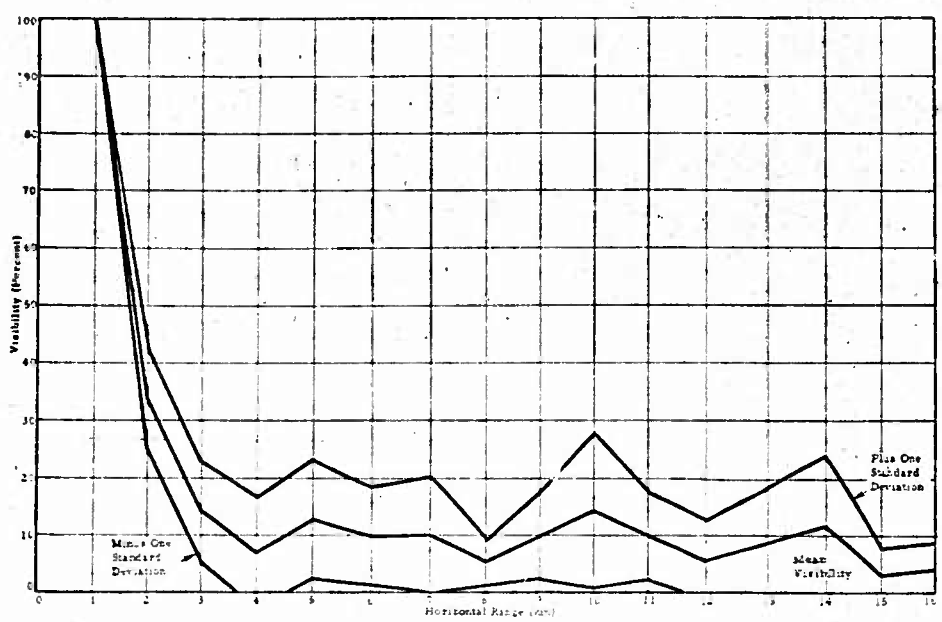


Figure 7-3 Visibility on the Central Plateau of South Vietnam From Ground Level

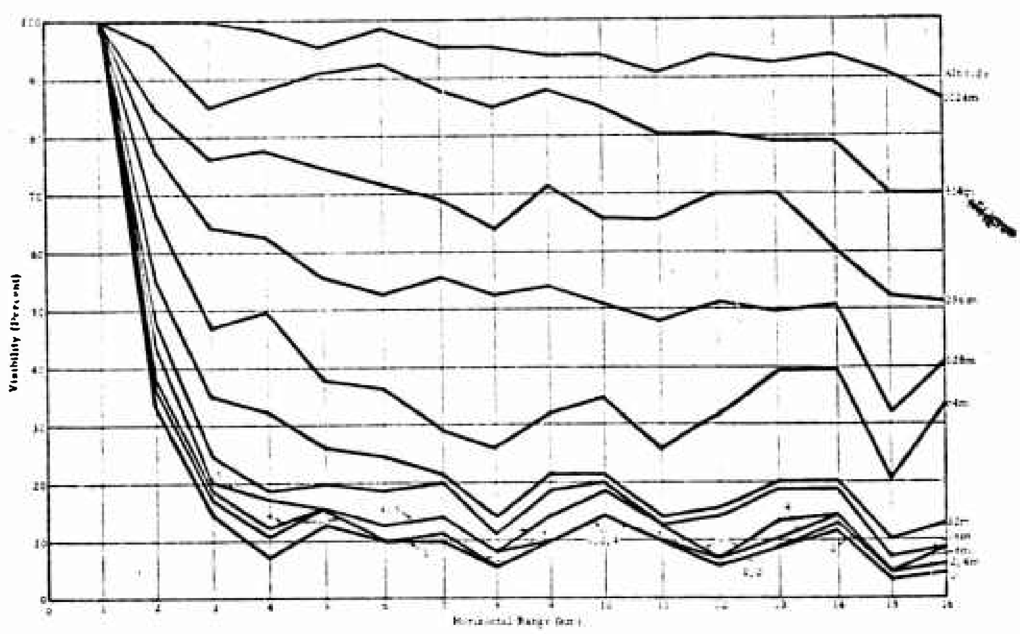


Figure 7-4 Visibility on the Central Plateau of South Vietnam as a Function of Range and Altitude Above Ground Level

7.5 CENTRAL MOUNTAINS OF SOUTH VIETNAM

The second area selected for analysis is located north-northeast of Plei Bre, on the map described as Vipee, Series L701, Sheet 6655II, Edition 1-AMS, 1:50,000, September 1964 (Figure 7-5). In contrast to the plateau region, visibility in the mountains is comparatively better. The mean visibility curves (Figure 7-6) have formed a peculiar pattern indicating a drop in visibility beyond the 3-km range, but not nearly as low as on the plateau. However, a sharp increase in visibility takes place at a range of 12 km followed by a rising trend that seems to continue beyond the 16-km range.

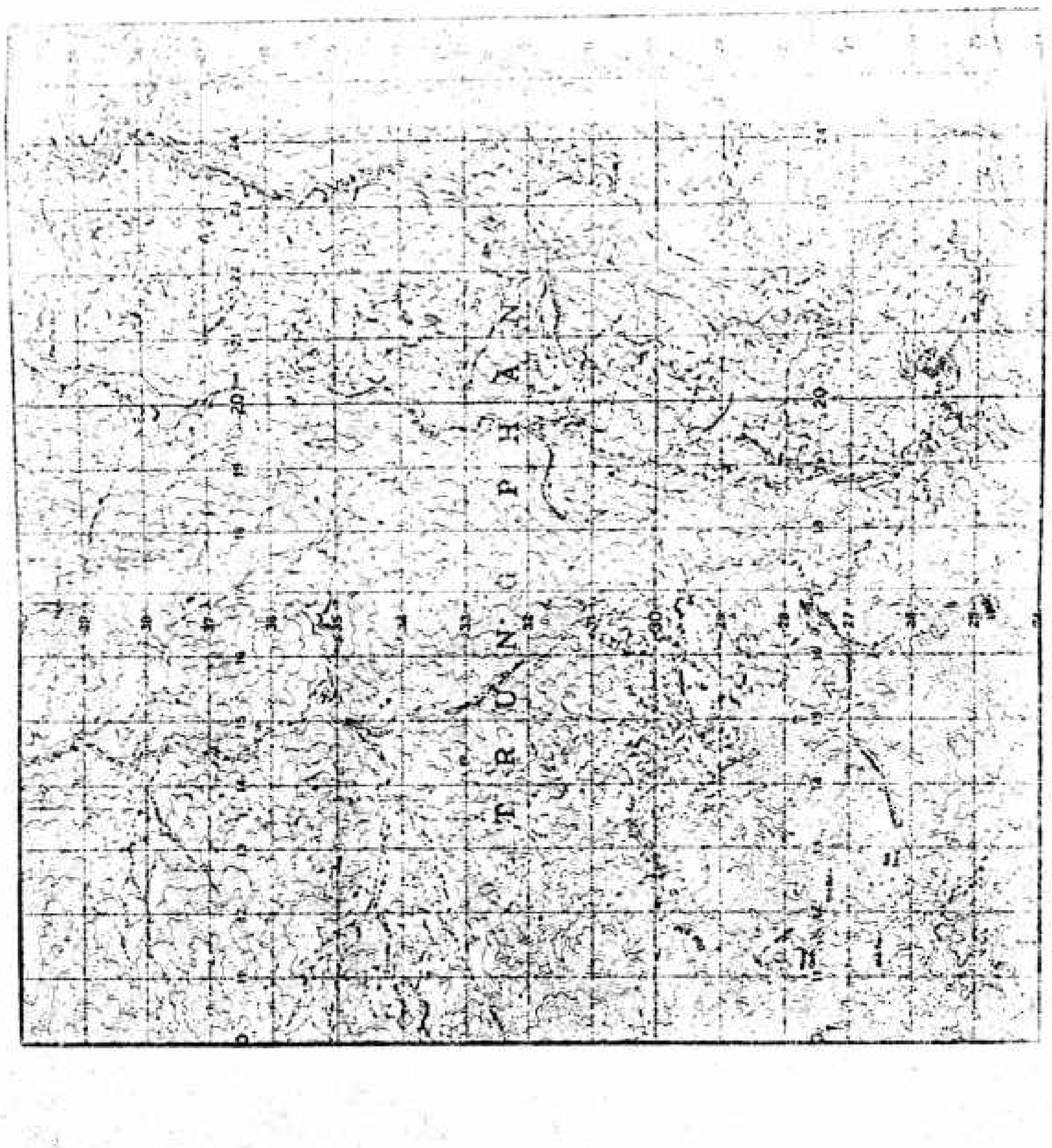
7.6 MEKONG DELTA

In comparison with the two preceding regions of high relief, a third area was chosen to represent a level lowland. This area is situated on the Mekong Delta which is so flat that the map has not a single contour line on it. Since a detailed vegetation cover is depicted on the map, arbitrary heights were assigned to each vegatation type to provide the elevation values for the constituent grid points. The map is identified as Gia Rai, Series L701, Sheet 6038I, Edition 1-NGS, 1:50,000 March 1964 (Figure 7-7).

The curves shown in Figure 7-8 indicate a gradual decline in visibility with increasing distance from the observation point. This trend remains the same for all altitudes up to 256 m above ground level, where 100% visibility is experienced. It should also be pointed out that from 16 m and 32 m above ground level visibility begins to improve at a range of 14 km and 13 km, respectively.

7.7 COMPARATIVE TERRAIN VISIBILITY

To illustrate the application of the terrain visibility curves, Figure 7-9 shows a plot of visibility at 8 km for the three regions. Here, the three terrain types are compared in regard to their line-of-sight characteristics as a function of altitude above ground level. It is clearly evident that best visibility is encountered on the Mekong Delta, followed by the Central Mountains up to an altitude of 95 m. At this point, the Central Plateau surpasses the mountains in visibility.


TRUNG PHAN

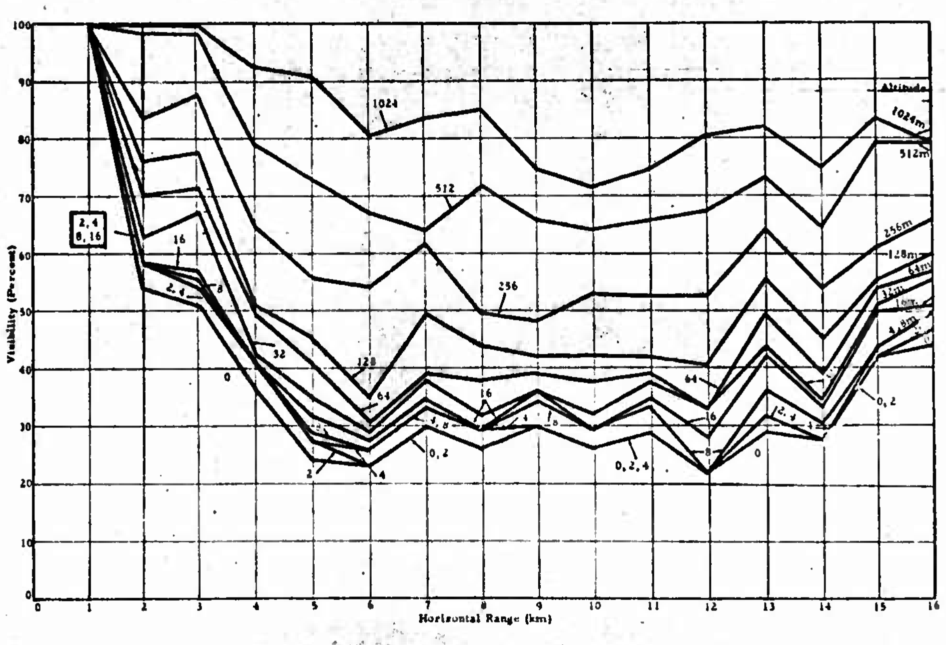


Figure 7-6 Visibility in the Central Mountains of South Vietnam as a Function of Range and Altitude Above Ground Level

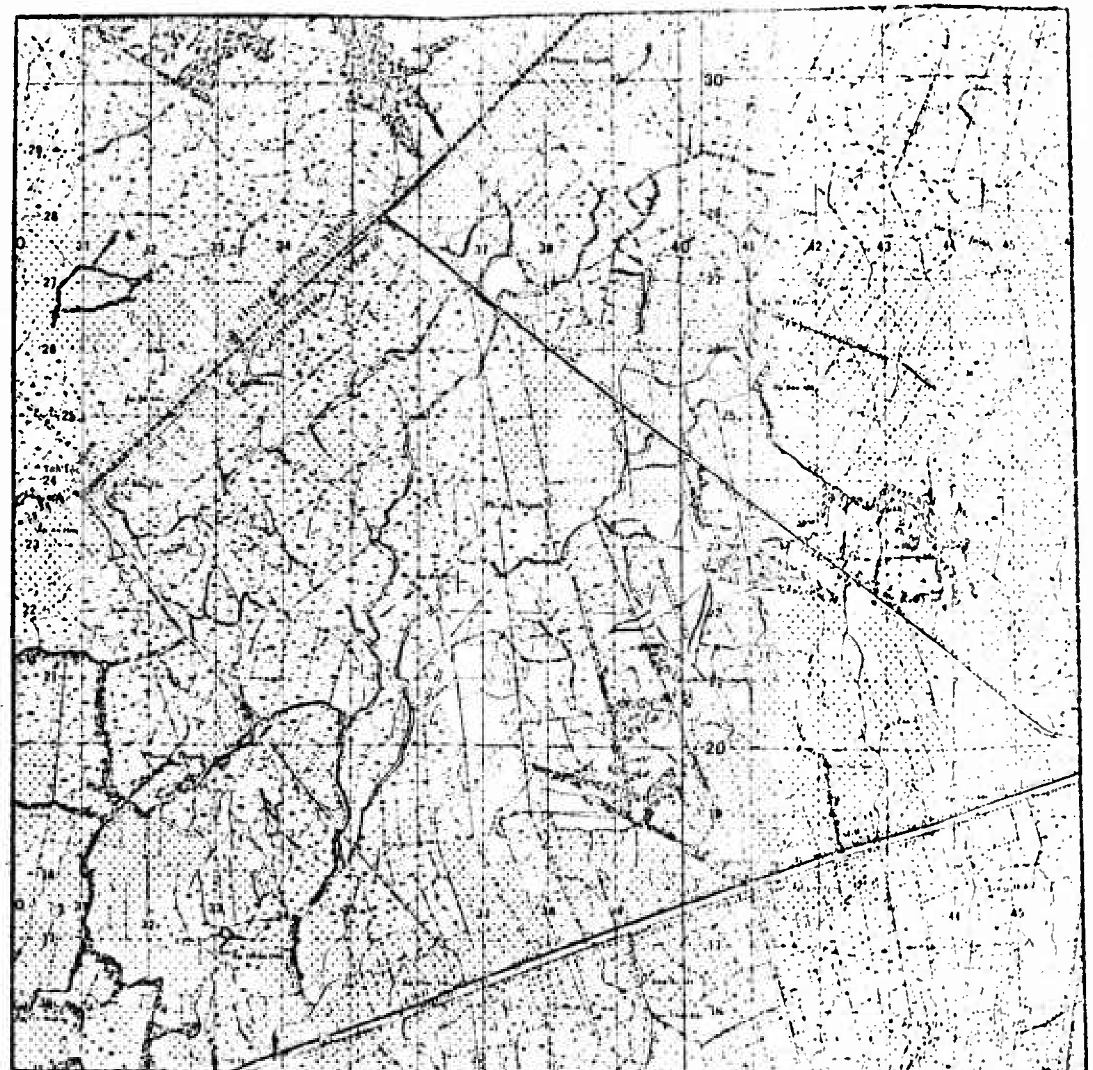


Figure 7-7 Gia Rai, Series L701, Sheet 6038 I, Edition 1-NGS, 1:50,000

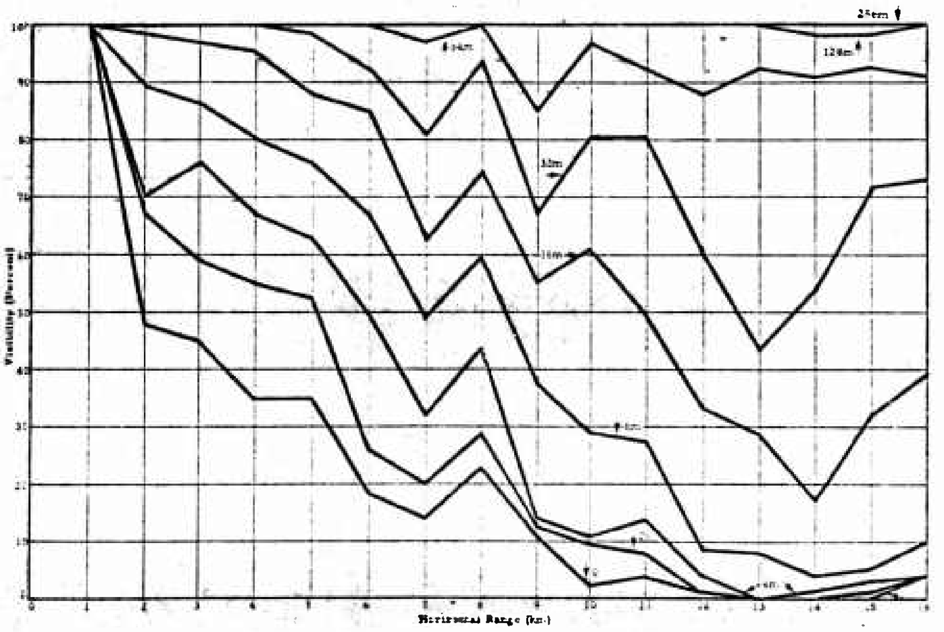


Figure 7-8 Visibility on the MeKong Delta as a Function of Range and Altitude Above Ground Level

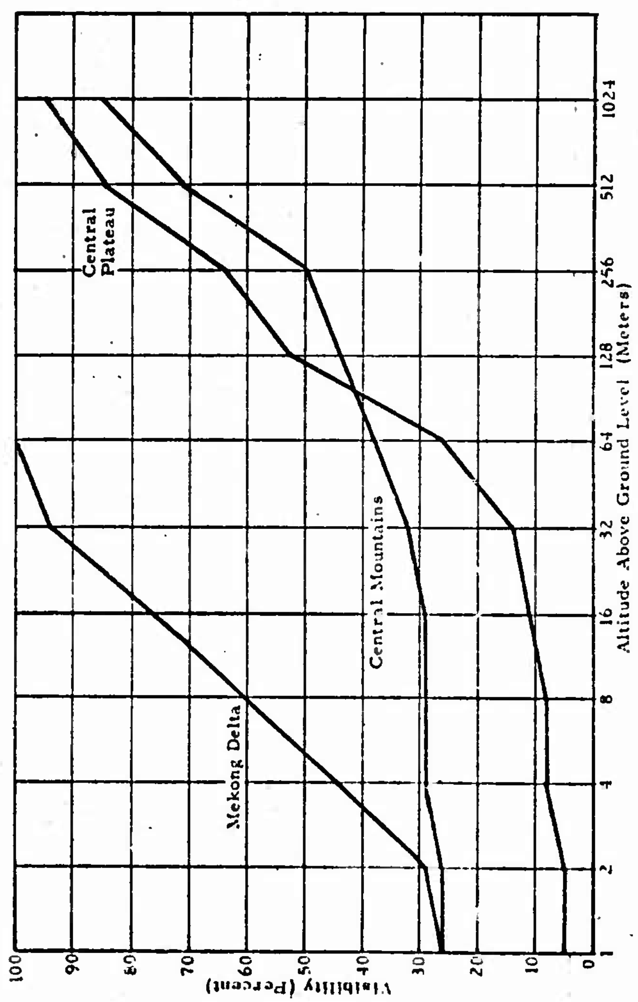


Figure 7-9 Comparative Visibility at a Range of 8 km

Unclassified
Security Classification

14 KEY WORDS	LINK A ROLE	LINK A WT	LINK B ROLE	LINK B WT	LINK C ROLE	LINK C WT
Climate						
Foliage						
Terrain						
Terrain Masking						
Weather						
Geography						
Indochina						
Europe						
Africa						
Near East						

INSTRUCTIONS

1. ORIGINATING ACTIVITY: Enter the name and address of the contractor, subcontractor, grantee, Department of Defense activity or other organization (*corporate author*) issuing the report.

2a. REPORT SECURITY CLASSIFICATION: Enter the overall security classification of the report. Indicate whether "Restricted Data" is included. Marking is to be in accordance with appropriate security regulations.

2b. GROUP: Automatic downgrading is specified in DoD Directive 5200.10 and Armed Forces Industrial Manual. Enter the group number. Also, when applicable, show that optional markings have been used for Group 3 and Group 4 as authorized.

3. REPORT TITLE: Enter the complete report title in all capital letters. Titles in all cases should be unclassified. If a meaningful title cannot be selected without classification, show title classification in all capitals in parenthesis immediately following the title.

4. DESCRIPTIVE NOTES: If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is covered.

5. AUTHOR(S): Enter the name(s) of author(s) as shown on or in the report. Enter last name, first name, middle initial. If military, show rank and branch of service. The name of the principal author is an absolute minimum requirement.

6. REPORT DATE: Enter the date of the report as day, month, year, or month, year. If more than one date appears on the report, use date of publication.

7a. TOTAL NUMBER OF PAGES: The total page count should follow normal pagination procedures, i.e., enter the number of pages containing information.

7b. NUMBER OF REFERENCES: Enter the total number of references cited in the report.

8a. CONTRACT OR GRANT NUMBER: If appropriate, enter the applicable number of the contract or grant under which the report was written.

8b, 8c, & 8d. PROJECT NUMBER: Enter the appropriate military department identification, such as project number, subproject number, system numbers, task number, etc.

9a. ORIGINATOR'S REPORT NUMBER(S): Enter the official report number by which the document will be identified and controlled by the originating activity. This number must be unique to this report.

9b. OTHER REPORT NUMBER(S): If the report has been assigned any other report numbers (*either by the originator or by the sponsor*), also enter this number(s).

10. AVAILABILITY LIMITATION NOTICES: Enter any limitations on further dissemination of the report, other than those imposed by security classification, using standard statements such as:

(1) "Qualified requesters may obtain copies of this report from DDC."

(2) "Foreign announcement and dissemination of this report by DDC is not authorized."

(3) "U. S. Government agencies may obtain copies of this report directly from DDC. Other qualified DDC users shall request through ________________."

(4) "U. S. military agencies may obtain copies of this report directly from DDC. Other qualified users shall request through ________________."

(5) "All distribution of this report is controlled. Qualified DDC users shall request through ________________."

If the report has been furnished to the Office of Technical Services, Department of Commerce, for sale to the public, indicate this fact and enter the price, if known.

11. SUPPLEMENTARY NOTES: Use for additional explanatory notes.

12. SPONSORING MILITARY ACTIVITY: Enter the name of the departmental project office or laboratory sponsoring (*paying for*) the research and development. Include address.

13. ABSTRACT: Enter an abstract giving a brief and factual summary of the document indicative of the report, even though it may also appear elsewhere in the body of the technical report. If additional space is required, a continuation sheet shall be attached.

It is highly desirable that the abstract of classified reports be unclassified. Each paragraph of the abstract shall end with an indication of the military security classification of the information in the paragraph, represented as (TS), (S), (C), or (U).

There is no limitation on the length of the abstract. However, the suggested length is from 150 to 225 words.

14. KEY WORDS: Key words are technically meaningful terms or short phrases that characterize a report and may be used as index entries for cataloging the report. Key words must be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location, may be used as key words but will be followed by an indication of technical context. The assignment of links, rules, and weights is optional.

Unclassified
Security Classification

Unclassified
Security Classification

DOCUMENT CONTROL DATA - R&D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) Bendix Systems Division 3300 Plymouth Road Ann Arbor, Michigan	2a. REPORT SECURITY CLASSIFICATION ~~SECRET/NOFORN~~ U 2b. GROUP Group 3

3. REPORT TITLE
Joint Army-Air Force Tactical Reconnaissance & Surveillance Study (JAAFTRSS) Appendix B Topography and Climate

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)
Final

5. AUTHOR(S) (Last name, first name, initial)

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
	272	9

8a. CONTRACT OR GRANT NO. AF18(600)-2804 b. PROJECT NO. 7990 c. Task No. 7990-76 d.	9a. ORIGINATOR'S REPORT NUMBER(S) BSR 1247 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)

10. AVAILABILITY/LIMITATION NOTICES
All distribution of this report is controlled. Qualified DDC users shall request through Hq AFSC (SCSRR) Andrews AFB, Washington, D.C. 20331

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
	Headquarters Air Force Systems Command Deputy for Systems, Directorate of Reconnaissance, Andrews AFB, Wash DC

13. ABSTRACT

This appendix presents summaries of climatological and topographical data for selected geographical regions. The regions include Indochina, Europe, Central Africa, and the Near East. An analysis of terrain contours with respect to visibility due to masking effects from observation points on the ground and at selected elevations is also included.

DD FORM 1 JAN 64 1473

Unclassified
Security Classification